AD___________

SPECIAL TECHNICAL REPORT

AD 733 415

HEAT STRESS AND CULTURE IN NORTH INDIA

BY

JACK M. PLANALP, Ph.D.

JULY 1971

U S ARMY RESEARCH INSTITUTE OF ENVIRONMENTAL MEDICINE
Natick, Massachusetts

UNITED STATES ARMY
MEDICAL RESEARCH & DEVELOPMENT COMMAND

581

SPECIAL TECHNICAL REPORT

HEAT STRESS AND CULTURE IN NORTH INDIA

by

Jack M. Planalp, Ph. D.
Cultural Anthropologist

U. S. Army Research Institute of Environmental Medicine
Natick, Massachusetts

July 1971

Human Adaptations to Climatic and Related Stresses
Work Unit 01 047
Military Environmental Medicine
D. A. Project No. 3A025601A827

United States Army
Medical Research and Development Command

The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

Citation of trade names in this report does not constitute an official endorsement or approval of the use of such items.

DDC AVAILABILITY NOTICE

Qualified requesters may obtain copies of this report from Commanding Officer, Defense Documentation Center (DDC) (formerly ASTIA), Cameron Station, Alexandria, Virginia 22314

A

DISPOSITION INSTRUCTIONS

Destroy this report when no longer needed.
Do not return to the originator.

FOREWORD

The heat produced by man's body is important in two ways: on the one hand it is a waste product of metabolism, most of which must be dissipated; on the other hand, it is required to maintain the warm blooded state which gives man and other mammals such a biological advantage over non-warm blooded animals. Even at rest, man's metabolic heat production is not inconsiderable; it is sufficient, for example, to bring a quart of water from room temperature to the boiling point; it is equivalent, also, to the heat generated by a 100 watt electric light bulb. It can approach 20 times this amount with very vigorous exercise, depending on physical condition. Impinging on the foregoing physiological picture are many factors which may interact with this metabolic heat so that it can become either a life saving force (e.g. an antidote to the cold) or a life threatening force (e.g. potentiation by hot weather); in the latter case it represents a time bomb carried by the individual throughout his lifetime. Some of the pertinent factors are: age, activity, nutritional state, health and cultural behavior patterns. This complex group of variables obviously requires a multi-disciplinary approach to understanding the problems of human adaptation and effective performance in extreme environmental heat. This applies to the military as well as the civilian population.

Dr. Planalp has written a highly readable monograph which should provide a broad spectrum of readers with valuable insights into these complex interactions. Indeed, one might have predicted that it would require a cultural anthropologist like Dr. Planalp to do justice to this subject. Such a person is above all interested in the longer term and cultural adaptations of man to his environment. In this connection, one can hardly visualize a more appropriate and interesting area of the world than the Indian sub-continent. Although this report ventures into a great number of different aspects of the problem, its focus is clearly on the nature and results of human adaptations to extreme environmental heat in North India.

DAVID E. BASS, Ph. D.
Deputy Scientific Director

SPECIAL ACKNOWLEDGMENT

In July 1967 the author transferred from the U. S. Army Research Institute of Environmental Medicine to the Earth Sciences Laboratory, U. S. Army Natick Laboratories, taking with him this research report in an incomplete state. With the permission of ESL, during the next four years I continued library research, writing, and revision of the manuscript on a part-time basis and eventually, over most of two fiscal years, was awarded formal funding for the completion of the study. Special acknowledgment is therefore made, and special gratitude expressed, to the U. S. Army Materiel Command and to its Earth Sciences Laboratory,* to the Director of ESL, Dr. L. W. Trueblood, and to my immediate supervisor, Dr. W. C. Robison, Chief, Geography Division.

*Now Earth Sciences Laboratory, U. S. Army Engineer Topographic Laboratories, at Fort Belvoir, Virginia

PREFACE

The idea for this study began to take shape in 1962, when I had occasion to ponder if there were any way that I, as a cultural anthropologist, could make some relevant input to a research organization whose chief concern was "environmental medicine", more specifically defined as the medical aspects of the natural or physical environment's climatic, ergonomic and biophysical relationships to modern military activities and performance. It appeared that my contribution would of necessity be very limited or oblique. However, I suddenly realized that, by a happy coincidence, I had long maintained a scholarly interest in, and had enjoyed nearly three years of first-hand experience with, one particular region of the world which quite possibly yields to no other in two pertinent respects: (1) it is the homeland of a dense and large population whose culture and way of life contrast markedly with those of the modern Western world; and (2) it is a region of exceptionally severe and prolonged climatic stresses (seasonally cold, hot-dry, and hot-humid), and one where at the same time a belated economic development still restricts any mass utilization of such technological buffers between man and the thermal environment as air conditioning, electric fans, and central heating.

The area to which I refer is, of course, the plains of northern India, and my subject began to take focus as an effort to bring together data from a number of academic fields having relevance to the adaptations of the North Indian population to, and its interactions with, the hot thermal environment. The subject is one which has apparently not previously been treated in any thoroughgoing manner, although my limited sampling suggested that a high percentage of the many hundreds of those published works of reminiscence, memoir and travel in India are likely to have at least a few comments on the obtrusive climate of that country.

On the other hand, most Indian writers take surprisingly little notice of stresses traceable to the thermal environment, seeming to display an acclimation that is intellectual as well as physical. For example, a leading Indian social scientist has been able to write some 200 pages constituting the authoritative treatise on Indian dress and costumes, in their historical and regional complexity, without once referring to any direct or indirect influence of climate on clothing![1]

---

[1] G. S. Ghurye. Indian Costume (Bombay: The Popular Book Depot, 1951)

As my research on the interrelationships of heat stress and culture in India progressed, I began to see that the subject has almost endless ramifications, involving many scientific and scholarly fields. I have paused often and perhaps too inexpertly to poke into some of these most fascinating divagations, inviting eclectic superficiality and hazard of error in the treatment of all of them. Groping his way through the appropriate specialized literature, especially in the realm of the biological and the medical sciences, the presumptuous social scientist is repeatedly struck by how quickly common-sense and ready-made generalities give way to expert bafflement and scientific disagreement. The more we seem to know, the less about it can we be quite certain!

It is my principal hope that the present effort may serve as a stimulus to further work by others, Indian and non-Indian, whether they call themselves anthropologists, bioclimatologists, epidemiologists, geographers, medical historians, physiologists, or something else. Indeed, I herewith especially request and encourage any and all eventual readers who would be kind enough to criticize, comment on, or add data and observations to the content of these pages to communicate directly with the author.

Innumerable people have helped substantially to make this monograph possible, although they are in no way responsible for its shortcomings. Above all, I am indebted to the U. S. Army Research Institute of Environmental Medicine and its Commanding Officers, LTC (Dr.) William T. Hall (1962-1965) and COL (Dr.) James E. Hansen (1965-1971). I am most grateful to the Surgeon-General of the Indian Army and to the Indian Council of Medical Research for the kind permission which they granted to field work in 1963-1964 and again in 1966, and for their willingness to assist in what must seem a research endeavor of considerable irrelevance to their pressing problems. Here I must also mention that fine model of soldier-doctor-diplomat, COL (Dr.) Richard F. Barquist, who was the senior medical officer with the U. S. Military Supply Mission to India during the period of my field work, and quietly helped to ameliorate the various and inevitable administrative and personal crises of those days with empathy and dispatch.

Special thanks are due to Dr. Russell W. Newman and Dr. David E. Bass (both of ARIEM), for their support from the very beginning, and especially to Dr. M. E. Opler (Univ. of Oklahoma), my <u>guru</u> in matters anthropological who has remained the most selfless of mentors to this day, and whose incalculable contributions to this study include making available to me the files of field notes on Madhopur and other villages of North India which were originally assembled at Cornell University. I am indebted to Dr. Nafis Ahmad (Univ. of Dacca), to Dr. Ralph F. Goldman (ARIEM), to Dr. Shaligram Shukla (Georgetown University), and to Dr. J. Michael Mahar

(Univ. of Arizona) for having read parts of earlier drafts of the manuscript and having provided their comments and criticisms. The superior finished quality of cartography included herein is owed to Mr. Aubrey Greenwald and to Miss Olive Lesueur of the Earth Sciences Laboratory. Miss Linda Woupio has expertly prepared the more complex tables, but should not be held responsible for any untidiness of textual appearance otherwise. These deficiencies, like those of content, must be charged to the author, who undertook most of the clerical preparation (over a period of months, and to a large extent in spare time).

Finally, I owe special gratitude to the kind and helpful guides and informants whom I found in India in the course of field work. Their number is legion and their contributions must be acknowledged, but can hardly be repaid. Truly, I would say with V. S. Naipaul that:

> Nowhere were people so heightened, rounded and individualistic; nowhere did they offer themselves so fully and with such assurance. To know Indians was to take a delight in people as people; every encounter was an adventure. (An Area of Darkness)

Among my benefactors were local officials, the maligned "bureaucrats", the bench-workers of national, provincial and municipal administration in North India. Others were in academic and medical professions. Here I should mention by name Dr. D. N. Sharma, Director of Medical and Health Services, U. P., and Dr. K. N. Udupa, Director of the Institute of Indian Medicine, Banaras Hindu University. My deepest personal thanks go to Shri Nath Singh (Ford Foundation, New Delhi), Ram Pratap Singh and Ram Rup Singh (Senapur, Dist. Jaunpur, U. P.), Dr. H. C. Shukla (Institute of Indian Medicine, BHU), and the staff of the U. P. Provincial Hygiene Institute in Lucknow, especially D. P. Bhatnagar and Dr. J. K. Sen Gupta. I was also ably assisted in Varanasi by Mrs. Sarla Gauba and by Raj Kumar Upadhyay, both then recent graduates of the Kashi Vidyapith University.

Undoubtedly, it is my wife, Sarla, who has undergone the greatest hardships incidental to the long travail of bringing this large monograph into print, and I gratefully acknowledge her never-failing help.

Jack M. Planalp

Natick, Massachusetts
July 1971

TABLE OF CONTENTS

Page

LIST OF ILLUSTRATIONS

LIST OF TABLES

NOTE ON TRANSCRIPTIONS

Wherever the Indian-language words in the text are not underlined and capitalized, diacritical marks are not provided. Where they are underlined, I have tried to follow standard linguistic usage in Romanization and transcription, much in line with the model provided by Village India (McKim Marriott, ed.). However, some inconsistencies and errors have undoubtedly crept in, partly because Hindi orthography is not yet well standardized, and there are many regional and dialectal variants. Dr. Shaligram Shukla, a linguist hailing from the Bhojpuri-speaking region, has given me much helpful guidance.

Where the Indian-language word is used in plural form, I have simply added an "s" in accordance with English usage, rather than attempting to give the proper Hindi or Bhojpuri plural. The following transcribed letters with a dot below are retroflex consonants: ṭ, ṭh, ḍ, ḍh, and ṇ. I have used "ri" rather than "ṛ" to designate the vocalic consonant or semivowel. Also, rather than follow the Nagari script distinction between श and ष, or "ś" and "ṣ", I have simply transcribed both as "sh", which approximates their spoken form. The letter "ṃ" is pronounced in the same position as the following consonant. The letters "bh", "dh", etc. are aspirates.

The five Hindi vowels, each having in the Nagari script a short and long form, are rendered herein as: a, ā; i, ī; u, ū; e or ē, ai; and o or ō, au. Whether or not the vowel in a given word should be transcribed as "e" or as "ē", as "o" or as "ō", has often baffled me. (Nagari script does not distinguish between them, but there can be a slight difference in length of the vowel in the spoken language.) I have generally taken Dr. Shukla's advice here. Nasalization of vowels, rendered by a superscript in the Nagari script, is shown in my text by the use of a tilde (~).

It should be noted that in Hindi the letters "a" and "i" (अ and इ) and "a" and "u" (अ and उ) never occur in sequence, and no possibility of confusion arises from using the Roman diphthongs "ai" and "au" to transcribe the Nagari letters ऐ and औ. But this is not true of the Bhojpuri dialect, where अ and इ, or अ and उ, can occur in conjunction. For Bhojpuri words, I have thus used a slant "a/i" and "a/u" to distinguish these combinations from "ai" (ऐ) and "au" (औ).

In case the reader is puzzled about variant spellings of the city known in ancient times as Kashi, and in the British imperial era as Benares, it may be noted that the official name at present is Vārāṇasī. However, many people still refer to the city as Banāras, and Banaras Hindu University, the famous national university located in the city and widely known as "B. H. U.", has up to now stubbornly refused either to change its first initial or to drop the sectarian designation.

NAMES AND DATES OF HINDU MONTHS

There are twelve months in the luni-solar calendar popularly used in North India to regulate festival and ritual events. Throughout the countryside these months are better known to Indians than are the months of the Western calendar. Their correspondences are as follows:

Hindi Name	Bhojpuri Name	Average Dates in Western Calendar
Caitra	Cait	March 12 - April 10
Vaishakha	Baisakh	April 11 - May 11
Jyeshth	Jeth	May 12 - June 11
Asharh	Asarh	June 12 - July 13
Shravan	Savan	July 14 - August 14
Bhadrapad	Bhadon	August 15 - September 14
Ashvin	Kuar	September 15 - October 14
Kartik	Katik	October 15 - November 13
Margshirsh	Agshan	November 14 - December 13
Paush	Pus	December 14 - January 11
Magh	Magh	January 12 - February 9
Phalgun	Phagun	February 10 - March 11

Since the lunar year is about 11 days shorter than the zodiacal year, it is necessary about every 33 months to insert an extra or intercalary month at the appropriate time. This means that in any given year the Western date equivalent of any lunar date may vary as much as two weeks in either direction from the average dates shown above. That is, the first day of the light half of Caitra may occasionally occur as early as February 26, and as late as March 26. Each Hindu month consists of 30 tithis ("days", although a tithi is necessarily of variable length depending on the time of the year, and averages less than 24 hours). The first 15 days of the Hindu month are in the "light" half, and the last 15 days are in the "dark" half of the month.

"After his first year in Calcutta, an Englishman can no longer sleep as he once slept, or eat as he once ate, and it is lucky if he drinks no more than he once drank. If you asked him to run, he would laugh in your face. I sometimes think that our uniform success in Indian warfare may be partially due to the fact that our countrymen, by long disuse, lose the power of running away."

— G. O. Trevelyan, The Competition Wallah (1864)

"To get accustomed to the Indian climate we may therefore regard as a simple impossibility."

— J. C. Dickinson, Tropical Debility (1874)

". . . the Indo-Gangetic plain is the Vampire of geography, which sucks out all creative energy and leaves its victims as listless shadows. The high mean temperature, together with its immense daily range of rise and fall, hardly allows the body to attend to anything more fruitful than the daily adaptation to the weather."

— Nirad Chaudhuri, The Autobiography of an Unknown Indian (1951)

"The sun makes an ally of the breeze. It heats the air till it becomes the loo and then sends it on its errand. Even in the intense heat, the loo's warm caresses are sensuous and pleasant. It brings up the prickly heat. It produces a numbness which makes the head nod and the eyes heavy with sleep. It brings on a stroke which takes its victim as gently as a breeze bears a fluff of thistledown."

— Khushwant Singh, Train to Pakistan (1956)

"The Indian mind is inscrutable even to the Indians. How do we expect America to delve within the labyrinth of our split personality and make any sense of what we really are?"

— S. K. Dey, Power to the People? (1969)

". . . it is impossible to write about India without mentioning the weather."

— J. K. Galbraith, Ambassador's Journal (1969)

". . . in India things are seldom what they are supposed to be, [and] almost any statement about the Sub-continent is true--and so is its contrary."

— Bernard Nossiter, Soft State (1970)

I

INTRODUCTION

A. The Study

The student of culture who investigates any aspect of behavior and belief in India today inevitably confronts several sources of influence, each a world of its own. There is first the actuality of a vast and varied population itself, mother to a thousand and one religious followings, tribal and ethnic vestiges, and occupational, caste and newer forms of social groupings. Deep within this complex contemporary scene lies the "great tradition" of Hinduism, a legacy of ancient civilization, of religion, of social order and of cultural values which is socially personified throughout the country in the Braham caste of priests and pandits and which has its own tradition and system of medicine known as Ayurveda.

As a result of many centuries of rule by Muslim invaders, a second major cultural tradition overlays and pervades modern India. It is particularly viable in relation to the important (some six per cent of the population in North India) Muslim minority, but in some of its expressions, such as the Unani system of medicine, it is an integral part of the lives of nearly everyone.

Finally, there is the world of Western and scientific technological influence, which plays an increasing role in the new India. In its medical expression, for example, it reigns supreme at the higher academic and governmental levels.

None of these worlds or dimensions of influence on present-day popular Indian concepts, attitudes and behavior can be ignored in describing a problem such as the subject of this study: heat stress and culture in North India. This monograph will endeavor to examine aspects of all these simultaneous Indian worlds, although they can no more be integrated here than they are in Indian life itself, where they often seem to constitute a cultural patchwork.

Ultimate investigation of the problem will lead into the specialized modern disciplines of physiology, biophysics, meteorology, etc., areas where the author, a cultural anthropologist, has little authority to venture. This report therefore focuses primarily on the practices, the beliefs and the hardships of ordinary men and women in North India, and most specifically in the region of eastern Uttar Pradesh, in relation to environmental heat. Data have been derived from my personal observations, from published and unpublished sources, and from queries directed to both traditional and Western-trained medical authorities in India. Most of all, they come from conversations and interviews with residents of the typical village of Madhopur in Jaunpur District and with some forty men and women representing many walks of life in and around Varanasi, U. P. during the latter part of 1963. It is their view of the world and of life as they live it which provides the basic theme in the present report.[1]

B. The People

This study is concerned with the people of North India,[2] or the central Indo-Gangetic plain, here regarded as essentially the states of Uttar Pradesh and Bihar, with populations today of nearly 85 million people and 55 million people respectively (see Figure 1). The definition is only approximate, however, since some adjacent portions of Modhya Pradesh, Rajasthan, Haryana and Panjab might well be included. Linguistically, this region is the heartland of the Hindi tongue, which in ordinary street use becomes Hindustani, a Hindi-Urdu blend. In much of Bihar and eastern U. P. the spoken dialect is Bhojpuri, which has

---

[1]Lest some of the descriptions in the present text seem to give an grim view of Indian socio-economic conditions to the reader, it should be noted that they refer notably to the region of which an official Indian publication has remarked: "The poverty of eastern U. P. has almost become a legend in the country ..." (National Council of Applied Economic Research 1965, p. 15).

[2]"North-central" would undoubtedly be a more accurate geographical term. Indeed, the Indian States Reorganization Commission, in its 5-zone administrative grouping, places UttarPradesh in the "Central zone" and Bihar in the "Eastern zone" of India (Bhat 1964, p. 302). However, for purposes of this study the simple descriptor "North India" is being used.

INDEX

HEAT STRESS AND CULTURE IN NORTH INDIA

ERRATA

[illegible]AT STRESS AND CULTURE IN NORTH INDIA

Page 1, par. 1, line 10	Delete "Braham" and replace with "Brahman"
Page 2, par. 2, line 5	Delete "Modhya" and replace with "Madhya"
Page 5, par. 3, line 1	Delete "At"
Page 6, par. 1, line 14	Delete "raize" and replace with "raze"
Page 7, par. [illegible], line 1	Delete "Utta" and replace with "Uttar"
Page 7, par. 1, line 17	Delete "District.[3]" and replace with "District to less than one per 100,000 people in several of the eastern districts.[3]"
Page 8, par. 1, line 3	Delete "viration" and replace with "variation"
Page 8, par. 2, line 22	Delete "forth-three" and replace with "forty-three"
Page 9, par. 3, line 15	Delete "R2." and replace with "Rs."
Page 12, par. 2, line 4	Delete "argmenting" and replace with "augmenting"
Page 15, par. 1, line 2	Delete "with" and replace with "while"
Page 26, par. 1, line 3	Delete "Galem" and replace with "Galen"
Page 28, par. 2, line 4	Delete "still in" and replace with "still sold in"
Page 38, par. 3, line 12	Delete "tody" and replace with "today"
Page 39, par. 1, line 6	Delete "pitch" and replace with "pith"
Page 40, par. 2, line 10	Delete "imaginery" and replace with "imaginary"
Page 41, par. 1, line 9	Delete "non-conducive" and replace with "non-conductive"
Page 46, par. 1, line 13	Delete "that" and replace with "the"
Page 47, par. 2, line 5	Delete "hourses" and replace with "houses"
Page 47, par. 2, line 8	Delete "later" and replace with "late"
Page 54, par. 2, line 12	Delete "dystentery" and replace with "dysentery"
Page 65, par. 1, line 1	Delete "are made"

Page 104, par. 2, line 7	Delete "foot buckboard" and replace with "foot, buckboard"
Page 104, par. 3, line 2	Delete "or" and replace with "of"
Page 110, [illegible], line 3	Delete "April-May" and replace with "May-[illegible]"
[illegible] 110, par. [illegible], line 4	Delete "July-August" and replace with "Au[illegible]-September"
Page 127, par. 2, line 3	Delete "of influence" and replace with "of adherence to this system are extremely variant. Yet, the lines of influence"
Page 142, par. 2, line 2	Delete "the" and replace with "and"
Page 144, par. 1, line 3	Delete "(1942)" and replace with "[1942]"
Page 151, par. 2, line 2	Delete "saying" and replace with "sayings"
Page 163, par. 1, line 6	Delete "<u>khesari</u>" and replace with "<u>khesārī</u>"
Page 181, [illegible], lines 15-16	Insert "8" to read "(see p. 8 above)"
Page 183, par. 1, line 2	Delete "propertion" and replace with "proportion"
Page 227, fn. 1, line 3	Delete period after "Sirocco" and replace with comma
Page 300, par. 2, lines 3 and 17	Delete "Bulandshahar" and replace with "Bulandshahr"
Page 301, par. 1, line 18	Delete "even pontine" and replace with "even to pontine"
Page 347, par. 1, line 19	Delete "appear" and replace with "appears"
Page 378, par. 2, line 20	Delete "tests" and replace with "texts"
Page 386, last line	Delete "head" and replace with "heat"
Page 396, par. 1, line 4	Delete "heat" and replace with "salt"
Page 404, par. 1, line 21	Delete "health" and replace with "healthy"
Page 423, par. 2, line 17	Delete "1940), it" and replace with "1940), that it"
Page 424, par. 2, line 8	Insert "232" to read "p. 232"
Page 426, par. 2, line 17	Delete "parameters, the" and replace with "parameters, the failure to do which constitutes the"
Page 428, par. 1, line 13	Insert quotation marks to read "Temperature,""

Page 428, par. 2, line 8	Delete "1962" and replace with "1952"
Page 438, par. 1, line 7	Delete "person will" and replace with "person at rest will"
Page 443, par. 2, lines 7-8	Delete "Tennenbaum and Sohar 1960"
Page 454, lines 14-16 (bibl. entry no. 5)	Delete this bibliographic entry
Page 463, par. 4, line 2	Delete "of" and replace with "or"
Page 465, par. 1, line 2	Delete "at least"
Page 470, par. 1, line 13	Insert comma to read "fruit, had"
Page 480, par. 5, line 3	Delete "This" and replace with "The latter"
Page 487, par. 3, line 7	Delete "bhistī" and replace with "bhistīs"
Page 496, last line	Delete "gur" and replace with "guṛ"
Page 498, par. 1, line 6	Delete "One" and replace with "On"
Page 503, par. 2, line 6	Delete "has" and replace with "had"
Page 510, par. 1, line 9	Add parenthesis to read "irritation"),"
Page 522, par. 2, line 6	Delete "in" and replace with "on"
Page 528, par. 3, line 2	Insert "by" to read "Nature enjoyed by"
Page 530, par. 2, line 12	Insert "occurs" to read ""spirit possession" occurs (either possession of"
Page 553, bibl. entry no. 4	Underline "Journal"

The above list does not include numerous instances of erroneous spacing between words and letters that are obvious to the reader.

Figure 1. India: Location of Study Area

colloquial supremacy over 43,000 square miles or 24% of the U. P. and Bihar land area (Tiwari 1960, p. xxxii).

A fundamental sociological feature of North India is the caste system, according to which every Hindu is born into a specific, hierarchically-ranked social grouping which tends to be also an occupational specialty. The number of castes (properly speaking, they are sub-castes) represented in any given village is likely to be less than 25, typically including Brahmans (priests and learned men), Kshatriyas (formerly kings, nobles and warriors but now essentially farmer-landowners), Kayasthas ("writers" or bureaucratic officials), Ahirs (cowherds), Baniyas (merchants and shopkeepers), Nais (barbers), Lohars (blacksmiths and carpenters), Kohars or Kumhars (potters), Dhobis (washermen), Camars (leather-workers and landless serfs), etc. Within a typical district having one or two million people and including an urban center, there may well be over 100 such distinct sub-castes, each of which is endogamous.

At Brahmans, Kshatriyas, Kayasthas and the various prosperous urban merchant castes by and large constitute the "upper castes". At the nadir of the social hierarchy are the "untouchables"--the Camars, Bhangis (sweepers and removers of filth) and others--the groups to whom Mahatma Gandhi sought to restore dignity by naming them Harijan or "Beloved of God". Between the top and the bottom caste layers just described are a large number of artisan and laboring sub-castes who may be characterized as "lower castes", although a few of them, or some families within them, may have attained essentially an upper-caste style of life, while others are as poor and disadvantaged as most of the untouchables.

These three major caste-based levels in north Indian society contain approximately equal numbers of the population. Generally speaking, they are also closely correlated with economic status, in the form of landed property, salaried position, or life-style. As a group, the members of the upper stratum hold nearly all socio-economic, political and intellectual authority, although less than ten per cent even of these constitute what we might call India's social elite. This "elite" consists of men who have at least twelve years of education, who speak English, who have economic means permitting the ownership of a car, or at least a motor scooter, and who occupy important or prestigious jobs. Virtually the whole of this group live in cities.

About 87% of the people in North India are rural by census definition; that is, they live in villages or towns having less than 5000 population.[1] At its extremes the rural-urban distinction is a significant one in terms of style of life. But it is blurred and not easily maintained, for Indian cities retain many features of village life and a considerable proportion of the urban population are migrant workers whose families remain in the village. The North Indian city typically includes spacious "Cantonment" and "Civil Lines" areas (formerly housing British officials) and one or more other modern colonies for middle- and upper-class residence. However, there are large concentrations of urban slum dwellers who live in b̄astis (semi-rural enclaves on the outskirts, tending to consist of single castes), jhuggis (hutment slums, often unauthorized but difficult to raize once they are built), etc. Finally, every city has its katra-"bazaar" or old residential area, with narrow dark lanes and congested shops or stalls on the ground floor, perhaps offices on the second floor, and tenement rooms on the third and fourth stories.

Indian socio-economic statistics are often at some variance with each other, reflecting differences in survey approach, population sample, etc. However, much of the relatively impoverished condition of material life in North India can be conveyed by a series of related statistics, of the following sorts.

For India as a whole, national income rose 64% between 1951 and 1966, but per capita income increased only 21%, from Rs. 247.50 to Rs. 298.30 per annum.[2] In Uttar Pradesh the figure was only Rs. 255 (Mishra 1968, p. 194), while Bihar is the poorest Indian state, with a per capita income about 20% less than that of U. P. (Overseas Hindustan Times, Febr. 22, 1969, p. 5). Panjab, the wealthiest state, enjoyed a per capita income 65% more than that of U. P., according to the same source.

---

[1] Towns of over 5000 population which have less than 1000 persons per square mile or less than 75% of whose adult males have non-agricultural occupations are also officially classified as rural.

[2] Throughout this report, wherever sums of money in Indian rupees (Rs.) are stated without an equivalent quotation in U. S. dollars ($U. S.), the following rates of exchange should be assumed for recent years: Rs. 7.50 = $1.00 (after June 5, 1966); and Rs. 4.7619 = $1.00 (prior to June 5, 1966).

Most socio-economic statistics for Utta Pradesh are slightly less favorable than those for India as a whole. Thus, in U. P. the annual per capita expenditure for clothing in 1961 was computed at about Rs. 20 and for health at Rs. 7. The average daily food intake per adult was probably somewhere between 1800 and 2400 calories[1] and average life expectancy was 39.4 years for males and 28.4 years for females (Census of India, 1961, Vol. XV, U. P., Part 1 B, p. 39). In U. P. also the male and female literacy rates were 27.3% and 7.0% respectively. About one person in 3000 had a B. A. degree or equivalent in science, engineering, technology, or medicine. The average land holding per rural family was five acres, of which three acres were sown or cultivated. The average net consumable grain available per adult per day was 15.22 oz. Although all except four U. P. towns over 20,000 population were electrified in 1961, only 7.2% of the village population was benefited by electricity.[2] Automobile registrations in U. P. ranged from 238 per 100,000 population in Lucknow District and 338 per 100,000 in Naini Tal District.[3]

---

[1]Reasons for imprecision in this figure will be discussed in Chapter III.

[2]The total electric capacity in U.P. in 1960 was 378,000 kwh, but with an annual growth rate of some seven per cent this figure has probably doubled by now, in 1970. But in 1960 the annual per capita consumption of electricity in U. P. was only 12.81 kwh, compared to an all-India figure of 28.94 kwh, and only 1.63 kwh of this consisted of "domestic light and small power". Most of Uttar Pradesh's electricity went for "industries including water works" (7.47 kwh per capita per year), irrigation (2.43 kwh), "commercial lighting and small power" (1.10 kwh) and "public lighting" (0.18 kwh) (National Council of Applied Economic Research op. cit., pp. 149-151).

[3]Sources from which these statistics were taken include: Hindustan Year-Book and Who's Who, 1966; Report on the State of Health of Uttar Pradesh; Census of India, 1961; Techno-Economic Survey of Uttar Pradesh; Statistical Outline of Indian Economy (Kulkarni 1968); and unpublished data from the U. P. Department of Economics and Statistics, Lucknow.

Figures of this kind, however useful in delineating an overall socio-economic profile of over-population, under-development, and poverty, tend to mask the high degree of contrast and viration within North Indian society which includes, for example, a number of millionaires and former Maharajas along with its poverty-stricken millions. It includes castes ranging from untouchables to ritually elite subcastes of Brahmans. It is composed of numerous Hindu sects and cults in addition to the large minority (6.5% of the U. P. population in 1960) of Muslims and smaller numbers of Christians, Jains and Sikhs (0.14%, 2.0% and 1.4% of the population, respectively). While the typical or average man in North India is a villager and a farmer, large numbers of the population fall into such occupational categories as shopkeepers, craftsmen, factory workers, students, government workers, transport workers, etc., and the variety of specialized occupations as well as styles of life is indeed enormous.

Although what was previously described as the Indian "social elite" is not easily identified, it may be illuminating to compare the socio-economic averages cited above (which, of course, are heavily weighted by the 87% of the population that is rural) with some statistics gathered about 1964 by the Indian Institute of Public Opinion. A countrywide sample of 1000 families of urban Indians was surveyed. About 22% of these families had monthly incomes of under Rs. 150, 51% between Rs. 150 and Rs. 500, and 24% over Rs. 500 (3% failed to answer the question or did not know). In short, the sample was approximately representative of the Indian urban upper-middle class, while the 24% of the sample earning over Rs. 500 per month would include many of the "social elite". Some statistics of relevance based on the survey of 1000 families are as follows: 21% of the families employed full-time domestic help (paid at the average rate of Rs. 24 per month), while another 30% of them used part-time domestic help. Three per cent used gas or electricity for cooking, while the remainder burned charcoal, kerosene or wood. Only one family had a washing machine; two families had an air-conditioner. But 60% had a radio, 30% a sewing machine, and 6% a telephone. Only 23% ate eggs and 49% used milk, but 33% drank coffee and 75% tea. Only 2% had ever tasted beef and 8% chicken, but 44% ate mutton occasionally. Forth-three per cent of the families had a bicycle, 5% an automobile, and 3% a motor cycle or scooter (Indian Institute of Public Opinion 1965, pp. 7-18).

A systematic study such as that of Shukla (Shukla n.d.) is required to document the large range of economic well-being in rural north India, even among the residents of a single village. Shukla divided a carefully selected sample of some 14,000 people in 32 villages in Jaunpur District into five groups based on land-holding. The 6.2% of the sample population in the largest land-holding group (averaging 17.7 acres per family) had an annual family income of Rs. 4987, all but Rs. 204 of it derived from farming. By contrast, the 36.2% of the sample population in the 1.0 - 2.5 acre land-holding group had a total annual family income of only Rs. 662.45, of which Rs. 389.45 derived from farming and Rs. 273 from other sources (crafts, paid labor, etc.). Anomalously, the most landless group, averaging only .55 acres of land per family, and consituting 31.7% of the sample population, had an average annual family income of R2. 733.30, larger than that of the previously described group. However, only Rs. 148.30 of this was derived from farming, the remainder undoubtedly being attributable to the earnings of village men temporarily working in the city. Significant differences in allocations of household budget and in livestock holdings were also reported by Shukla, as well as a large difference in daily calcric intake between the highest and the lowest strata of land-holders (reportedly 3068 calories vs. 2162 calories, although it is not clear how these values were determined.)

C. The Climate[1]

The climate of the Indian sub-contient is primarily dictated by two factors: latitude and the monsoon winds. At eight degrees north latitude, the southern tip of India is well within the equatorial belt, while the northernmost extension of the North Indian plains, at about the Panjab-Kashmir border, is only slightly more than 32^{0} north latitude, equivalent to San Diego, California or Savannah, Georgia.

---

[1]Recommended general sources for the North Indian climate are: Climatological Atlas of India (1906); Chatterjee (1954); Spate (1954); and The Gazetteer of India (1965).

The region of central northern India, which is the primary focus of this study, and including most of the states of Uttar Pradesh and Bihar, lies at approximately 22^{0} - 28^{0} north latitude, which on the North American continent would be centered at about the latitude of the southern tip of Texas or of Florida. The climatic regime of mild to cool winters and hot summers which this continental latitude would ordinarily dictate is rather profoundly modified in India by the seasonal monsoon patterns. The general climatological profile of north India can be illustrated by monthly meteorological tables for Allahabad (Bamrauli Aerodrome), a centrally-located and representative station (see Table 1).

Europeans generally find November and February to be the most comfortable months in North India (Ambler 1966, p. 275). In every other month except December and January the average daily maxima are above 90^{0} F., while in December and January the average daily minima fall to a chilly 47^{0} F., a cold made more uncomfortable by the complete absence of central heating in houses and buildings.[1] Ground frosts often cause damage to field crops, occasionally injuring them severely. However, there are only a few cloudy days in the course of a normal winter and the almost daily warming effect of bright sunshine goes far to bring December and January also within the comfort zone.

That combination of warmth, moisture and greening vegetation which gives the season of Spring its special charm in temperate zones is lacking in North India. The leaves of many trees fall and are replaced by new growth in a brief continuous process in February and March. There is little if any rain from February onward and the ground and vegetation become dry and dusty. Although mango and some other varieties of trees blossom at this time of year, it is more importantly a time of crop fruition, of approaching wheat and barley harvests. Actually, North India has no Spring in the

---

[1] A recent study by Raghavan (1965) establishes a statistical basis for my impression that North India's occasional cold waves are indeed relatively severe (see Planalp 1966). Raghavan counted the number of cold waves between 1911 and 1961 throughout India, and calculated their characteristics. While the largest <u>number</u> of cold waves occurred in the Jammu-Kashmir region, the most <u>intense</u> cold waves, in terms of departure from normal temperature and duration in time (up to 19.8^{0} F. and seven days, respectively) were found in the states of Bihar and Uttar Pradesh.

Table 1. Allahabad. Climatological Summary

	Temperature (°F.) Average Daily Max.	Average Daily Min.	Average Monthly Max.	Average Monthly Min.	Absolute Max.	Absolute Min.	Relative Humidity (%) 0800	Relative Humidity (%) 1700	Average Monthly Precip. (in.)	Wind Speed at 0800 (mph)	Cloudiness (tenths of sky) 0800	Cloudiness (tenths of sky) 1700	Bright Sunshine (hrs. per day)
January	75	47	83	39	88	32*	83	40	0.9	2.6	2.8	0.7	8.4
February	79	51	90	44	97	34	69	35	0.6	3.2	3.0	1.2	9.1
March	92	60	101	53	107	45	47	18	0.6	3.8	2.1	0.5	8.8
April	10[illegible]	71	110	63	113	55	35	14	0.2	4.1	2.2	0.5	9.8
May	107	80	114	73	117	63	38	19	0.6	4.7	1.6	0.3	10.0
June	103	83	113	75	120*	67	59	43	5.0	5.3	4.9	2.4	7.1
July	92	80	100	75	114	72	82	74	12.6	4.8	8.2	4.7	5.4
August	39	79	96	75	104	73	87	78	10.0	4.3	8.3	5.0	4.9
September	91	77	97	73	103	65	82	69	8.4	3.7	5.4	2.8	6.9
October	90	67	96	59	105	53	70	48	2.3	2.3	2.2	1.1	9.3
November	83	54	90	48	96	43	70	40	0.3	1.7	1.5	0.5	9.4
December	76	47	82	41	87	30*	80	45	0.3	2.1	2.0	0.4	9.0
Annual Total or Mean	90	66	98	60	104	53	67	43	41.8	3.5	3.7	1.6	8.1

Period of Record: 1831-1941. Location of Station: 25°17' N. 81°44' E. Altitude: 322 feet above sea level.

*New record temperatures known by the author to have been established since 1941.

Sources: (1) Great Britain. Air Ministry. Meteorological Office. Tables of Temperature, Relative Humidity and Precipitation for the World. Part V. Asia.

(2) India. Meteorological Department. Climatological Tables of Observatories in India.

European sense, and the village boys and girls also tend to pass quickly from childhood to adult roles with little of the Springtime of adolescence.[1]

The onset of summer is graphically described by Marriott: "Grass and weeds are carefully dug up, roots and all, to be used as animal fodder. All usable leaves are stripped off the trees systematically. The entire land lies absolutely bare and brown for three months of each year; the air, too, is brown, for it is full of the precious soil, dried and blown about as dust. (Marriott 1952, p. 263)[2]

The hot-dry or "summer" season usually reaches its peak during the last two weeks of May and the first two weeks of June, although potentially lethal heat waves can occur as early as April. This heat is accompanied by increased air turbulence, convective currents forming the "loo" (*lū*), a simoom-like wind which usually blows most strongly at mid-day in response to steep atmospheric pressure gradients. However, these hot westerly winds sometimes continue through the evening and night also. The *lū* is a phenomenon of special dread in North India, as we shall see. *Ānhīs* or duststorms occur during the summer and may be so severe as to cause almost total darkness during the day or, if they come at night, literally to choke off sleep, and in any event to leave a thick coat of grit throughout the houses.

While official daytime temperature records reach nearly 120° F.

---

[1] In this connection, the comments of Maclachlan are suggestive. He notes that Americans assume a five-stage life pattern: infancy, childhood, adolescence, maturity and old age. But in much, probably most, of the world (and this is certainly true in traditional India) there is a three-stage pattern: childhood, maturity and old age (Maclachlan 1958, p. 98).

[2] My only disagreement with this description, at least for much of eastern U. P., is that the April-June countryside has a much higher albedo than the color "brown" would suggest. In some places the soil is almost white-gray in appearance, thus argmenting the effect of solar radiation.

at most North Indian weather stations, considerably higher readings can be obtained in dead-air locations in cities and where there may be added radiant and convective heat effects from sun, exposed rock outcroppings, buildings and pavements, etc. Insolation in the summer season is affected by the large amount of dust in the atmosphere,[1] a situation described subjectively and very feelingly by Goodfriend:

> . . . During Delhi's summer there was no sun, no visible orb, no single source of light and heat. Rather, the sun suffused the air, turning each particle into an ember that scorched the skin, withered the insides of the nostrils, and suffocated the lungs. (Goodfriend 1963, p. 177)

The approach of the monsoon ushers in a period of great irregularity and unpredictability of weather. The monsoon (strictly speaking, the southwest monsoon) crosses North India from east to west from the Bay of Bengal to the Northwest Frontier. It normally reaches eastern U. P. about June 20, but can arrive one or two weeks earlier or later and with widely varying amounts and patterns of rainfall. Sometimes there are pre-monsoon showers and cooling breezes; sometimes, instead, there are enervating increases in humidity with high temperatures.

Over the next four months the rainfall in Allahabad normally totals 36 inches, and on 43 out of 122 days there is measurable precipitation (0.1 in. or more). However, the monsoon regime is highly unstable and while up to 10.5 inches of rain in a 24-hour period have been recorded in Allahabad, every year there are several cloudless breaks in the monsoon of from two days to a week or more when high heat and high humidity occur in combination. In general the rainy season is a time of rapid change and contrast, not so much in dry bulb temperature as in sentient or effective temperature. The average monthly minimum temperature in Allahabad in both July and August is 75°F., but after

---

[1]In Allahabad, the month with the highest average daily solar radiation on a horizontal surface is, surprisingly enough, April: 650 cal/cm^2/day, despite an average daily duration of bright sunshine of 9.8 hours per day. May has 10.0 hours of sunshine and the sun is at a higher angle, but due to the increased dust in the atmosphere (and to slightly more moisture, on average) the radiation load in May is only 600 cal/cm^2/day (Mani, Swaminathan and Venkiteshwaran 1962, p. 199).

two or three days of nearly incessant rain even this temperature can feel unpleasantly cool. However, daytime readings of 102° F. with extreme humidity may occur during breaks in the monsoon, and in a five-year study of dew-point temperatures in Lucknow, the highest of the year (86° F.) was found to occur in September (Pramanik and Hariharan 1951, p. 140). Villagers comment on the fact that the sun's rays seem especially intense during breaks in the monsoon (even though the angle of inclination of the sun diminishes progressively from its June peak), since the air is washed entirely free of dust. The relatively rapid transitions between steaming and chilling (almost a diurnal pattern in late August and September because of the very heavy dews) is also cited by North Indians as the cause of the epidemiological fact of a marked increase in sickness and fever as the rainy season progresses. A 20th century English climatologist appears to agree with them:

> The hot sun beating down on the saturated ground, after the rains have left, draws up mists and vapors from the swamps, with their attendant fevers and rheumatism which, to an appalling degree, swamp the energies of the Indian peasant. (Miller 1943, p. 145)

Since the description of human environmental adaptations in the following pages covers a period of over 2000 years, the question arises as to what secular changes in climate, if any, may have occurred during this period in North India. The subject is one rampant with hypothesis and speculation (see Lamb 1966), but very uncertain as to fact. However, Lamb has suggested that during the period 4000 - 2000 B. C. world temperature was on average some 3.6 F.° higher than at the present time, then gradually fell to the point where from about 500 B. C. - 500 A. D. European glaciers re-advanced and lakes rose (Ibid., p. 7). North India, now often described as a "treeless plain", was heavily forested in Vedic times. Even as late as the seventh century when described by Chinese Buddhist pilgrims,

> There is reason to believe that rainfall was rather heavier than in recent years . . . (Basham 1963, p. 194)

Cereals were grown in what is now the Rajasthan desert during the Harappan civilization, the water table in northwest India was much higher, and the moisture lingered on sufficiently to make possible Alexander's march to India in 327 B. C. (Lamb 1968, p. 114). Average temperatures at this time may have been as much as 3.6 F.° lower than at present.

Another warm cycle may have reached its peak about 1000 A. D., with another cooler period (sometimes called the "Little Ice Age" in Europe) occurred between 1550 and 1850. So far as the recent past is concerned, Kraus has noted a steady increase of pressure amplitude over North India during the 20th century, which has resulted in colder winters and hotter summers (Kraus 1956). Of course, the average temperature changes referred to here as secular trends are extremely slight, compared to the unpredictable week-to-week and year-to-year fluctuations in temperature and precipitation. There may have been a trend to retardation of the southwest monsoon across North India during this period, for O'Meara mentions in passing that in the 1890's the monsoon reached western U. P. about June 15, but thereafter became gradually later until, in the 1930's, it did not reach that area until as late as July 20 (O'Meara 1935, pp. 63-4). However, the map of monsoon progression in Platt's recent compendium shows a date of onset for western U. P. of about June 20 - 25 (Platt 1962, pp. 20-1)

LIST OF REFERENCES

Ambler, H. R. 1966. "Conditions of thermal comfort in North India", Journal of Tropical Medicine and Hygiene, Vol. 69, pp. 275-281

Basham, A. L. 1963. The Wonder that Was India. New York: Hawthorn Books

Bhat, L. S. 1964. "Aspects of regional planning in India", pp. 297-322 in Geographers and the Tropics: Liverpool Essays (Robert W. Steel and R. Mansell Prothero, eds.). London: Longmans, Green

Chatterjee, Sujan B. 1954. Indian Climatology. Calcutta: Commercial Printers

Goodfriend, Arthur. 1963. The Twisted Image. New York: St. Martin's Press

Great Britain. Air Ministry. Meteorological Office. 1958. Tables of Temperature, Relative Humidity and Precipitation for the World. Part V. Asia. London: H. M. S. O.

Hindustan Year-Book and Who's Who, 1966. 1966. Calcutta: M. C. Sarkar

India. 1961. Census of India, 1961

India. Central Gazetters Unit. 1965. The Gazetteer of India: Indian Union. New Delhi: Ministry of Information and Broadcasting

India. Meteorological Department. 1906. Climatological Atlas of India. Edinburgh: J. Bartholomew

India. Meteorological Department. 1953. Climatological Tables of Observatories in India. Delhi

Indian Institute of Public Opinion. 1965. "The anatomy of Indian urban poverty", Monthly Public Opinion Surveys, Vol. 10, No. 7-8

Kraus, E. G. 1956. "Secular changes of the standing circulation", Royal Meteorological Society, Quarterly Journal, Vol. 82, pp. 289-300

Kulkarni, Vijay G. 1968. Statistical Outline of Indian Economy. Bombay: Vora and Co.

Lamb, H. H. 1966. The Changing Climate. London: Methuen and Co.

_____. 1968. "The climatic background to the birth of civilization", The Advancement of Science, Vol. 25, pp. 103-120

Maclachlan, John M. 1958. "Cultural factors in health and disease", pp. 94-105 in Patients, Physicians and Illness (E. Gartly Jaco, ed.). Glencoe: The Free Press

Mani, Anna, Swaminathan, M. S. and Venkiteshwaran, S. P. 1962. "Distribution of sunshine and solar radiation over the Indian peninsula", Indian Journal of Meteorology and Geophysics, Vol. 13, pp. 195-212

Marriott, McKim. 1952. "Technological change in overdeveloped rural areas", Economic Development and Cultural Change, Vol. I, pp. 261-272

Miller, A. Austin. 1943. Climatology. New York: E. P. Dutton (3d ed.)

Mishra, S. M. 1968. "Industrial prospects of Uttar Pradesh, India", p. 194 in 21st International Geographical Congress. Abstracts of Papers (Sivaprasad Das Gupta and Teresa Romanowska-Lakshmanan, eds.). Calcutta: National Committee for Geography

National Council of Applied Economic Research. 1965. Techno-Economic Survey of Uttar Pradesh. New Delhi: NCAER

O'Meara, Eugene John. 1935. I'd Live It Again. London: Jonathan Cape

Overseas Hindustan Times

Planalp, Jack M. 1966. *Cold Injuries in the Tropics: the North Indian Cold Wave of 1961*. Natick, Mass.: U. S. Army Research Institute of Environmental Medicine (unpublished manuscript)

Platt, Raye R. (ed.) 1962. *India: a Compendium*. New York: American Geographical Society

Pramanik, S. K. and Hariharan, P. S. 1951. "Maximum dew-point temperatures in India", *Indian Journal of Meteorology and Geophysics*, Vol. 2, pp. 138-141

Raghavan, K. 1965. "Some aspects of severe cold waves in India", *Current Science*, Vol. 34, pp. 401-403

Shukla, B. D. n.d. (1965?) *Agricultural Saving and Investment in Jaunpur District, Uttar Pradesh*. Varanasi: Banaras Hindu University College of Agriculture

Spate, O. H. K. 1954. *India and Pakistan*. London: Methuen and Co.

Tiwari, Udai Narain. 1960. *The Origin and Development of Bhojpuri*. Calcutta: Asiatic Society

Uttar Pradesh. Directorate General of Medical and Health Services. 1961. *Report on the State of Health of Uttar Pradesh*. Lucknow

II

ADAPTATIONS TO HEAT IN THE PAST

A. The Ayurvedic Tradition

To a degree probably unequaled elsewhere in world history, the philosophers and scholars of ancient India elaborated exhaustive but mainly speculative systems for categorizing phenomena in the universe. Every Hindu art and science, from politics to architecture, from music to medicine, was interwoven with the basic Indian metaphysical and philosophical constructs. However, since these derive from several distinct schools of philosophy they are perhaps too heterogeneous, even self-contradictory, to be called a single system. This is nowhere more true than in the case of the medical art or science.

To understand the traditional or classical Hindu approach to the various aspects of heat stress and heat effects it is necessary to explore the concepts of Ayurveda, the "Wisdom of Long Life" which is the essential system of Hindu indigenous medicine.[1] Ayurveda today is a vast concretion of general principles, therapeutics and materia medica, the cumulative work of centuries and generations of early physician-surgeons. The best-known sourcebooks of Ayurveda, however, remain the <u>Caraka Samhitā</u> and the <u>Sushruta Samhitā</u>, compilations attributed to Caraka (1st century A. D.) and Sushruta (4th century A. D.).

One chapter of the <u>Caraka Samhitā</u> is devoted to <u>ritucarya</u> or regimen. According to Caraka the year is divided into two halves, each containing three seasons (<u>ritu</u>) as follows:

---

[1]See Appendix A: Description of Ayurvedic Medicine.

Preceding page blank

I. "Taking" or "Absorbing" Half

Shishira	(Winter season)	mid-December to mid-February[1]
Vasanta	(Spring season)	mid-February to mid-April
Grishma	(Summer season)	mid-April to mid-June

II. "Giving" or "Liberating" Half

Varsha or Pravrish	(Rainy season)	mid-June to mid-August
Sharad	(Humid or Dewy season)	mid-August to mid-October
Hemanta	(Autumn season)	mid-October to mid-December

The "Taking Half" of the year is so named because the Sun is in its northward course and, according to Ayurvedic belief, during this period the deified Sun dominates earthly life, taking away or absorbing moisture and energy from the earth and its creatures. During the "Giving Half" the Moon is believed to be dominant and to act as a replenisher and restorer of vitality.

---

[1]These monthly approximations are my own, and differ slightly from those provided by most English-language translators of the Caraka Saṃhitā, who give slightly later monthly equivalents for the six ṛitus, e.g. Vasanta = March-April; Grishma = May-June; etc. While Caraka did not identify the seasons with months, the Arthashāstra did so in terms of the Hindu luni-solar calendar (Agrawala 1953, p. 179), and its correlation approximates that given here, which certainly better reflects the climate of U. P. and Bihar. Probably the discrepancy is attributable to the fact that during the Vedic period the Aryans were mostly settled west of the Yamuna (Jumna) River--the present-day Panjab and West Pakistan--where monsoon effects arrive later than in central North India, the area of this study (Mukherji 1968, p. 179). At best there are always difficulties in making calendrical correspondences because Hindu solar, luni-solar and lunar calendars are not uniform throughout the country and the ancient Indian astronomers failed to take into account the precession of equinoxes, resulting in a slippage of several days since the time of Caraka (Kincaid 1943, p. 257).

While Ayurvedic and classical Indian literature speak of six seasons, they recognize three seasons as basic and distinctive, while the remainder are essentially transitional periods. This is also the idea of the average North Indian today and it represents no more than a straightforward translation of the extremes in temperature and humidity visible in the modern climograph of any north Indian weather station, such as that of Allahabad (see Figure 2). Thus, a winter or cold period (December-February), a summer or hot-dry period (April-June), and a rainy or humid period (July-September) are the three landmark seasons of the year, each with its own distinctive characteristics (and stresses) which are forcefully impressed on the awareness of the people subject to their regime.[1]

According to Ayurveda, seasonal changes are a major cause of disturbance to the bodily equilibrium which constitutes good health. Their effects are both direct, through temperature, humidity, solar radiation, etc., and indirect, acting upon water and food plants. Caraka notes that in mid-winter man's energy and vitality are at the highest peak. The "gastric fire" is then capable of digesting large quantities of food, as well as food having a "heavy" quality. Indeed, the body demands such food, and specific imbalances arise if the demand is not met. Thus, in winter one should eat foods of the "oily", "acid" and "saltish" categories, meat (especially meat of animals native to aquatic or marshy habitats), wine, honey, milk, sugar cane juice, animal fat, oil and new rice. One should drink hot water and should resort to oil massages, hot-house sudation, sunbaths, cellars and other warm places. Clothing should, of course, be warm and thick, and quilts, skins and furs are recommended as covering for sleeping. A thick paste made from eaglewood should be plastered on the body for warmth. Winter is also the preferred time for sexual activity:

> One should lie in bed with a plump and passionate woman, warmed up by aphrodisiac wines, and spend the night in her embrace. (The Charaka Samhita, Vol. II, p. 98)

---

[1]Endeavoring to align the Indian climatic seasonal year with that of the temperate zones, the Indian Ministry of Food and Agriculture's Indian Crop Calendar proposes the following standard four-season classification: spring (Febr. 15 - Apr. 15); summer (Apr. 15- Sept. 15); autumn (Sept. 15 - Oct. 31); and winter (Nov. 1 - Febr. 15) (India. Ministry of Food and Agriculture 1956, p. 13). But this formula ignores the important differences between the hot-dry and the hot-wet seasons.

However, daytime sleep or naps are strictly forbidden. By implication, winter is a time for an "early to bed and late to arise" schedule.

In the period of Vasanta or spring (mid-February to mid-April), certain definite humoral imbalances tend to develop as a result of the excesses of the previous season affected by the increasing heat and the drying, burning, vitality-sucking rays of the ascendant sun. Caraka recommends various medicinal purging procedures. This is also the season for indulging in physical exercise and athletics. Dry massage is prescribed, as well as frequent bathing with tepid water. One should eat foods of "medium" rather than "heavy" or "light" quality, including the meat of such animals as rabbit, antelope, quail, and partridge.

During the burning, desiccating summer season human vitality reaches its nadir. Caraka advises one to eschew sexual activity and all physical exercise, to nap or sleep at midday in a cool room, and to sleep at night on an open terrace, exposed to the moon and breezes. Garments of light silk were in fact used in India in the hot season (Upadhyaya 1947, p. 28). Both men and women applied a paste of finely ground sandalwood dust, often colored with lac or dyes, in patterns for cosmetic effect, and for coolness, Caraka held it desirable to be in contact with pearls and gems and to be fanned by fans dipped in sandal water. Caraka recommended "light" food, especially that in which the "sweet", "cool", "liquid" and "oily" properties predominate. "Saltish", "acid", "pungent" and "hot" food and drinks should be avoided. Wine should not be imbibed and water should be drunk after boiling and cooling. Some foods specifically recommended are <u>shalī</u> rice (that which grows in damp soil or a water-covered field) with ghee and milk, cool barley meal with sugar, and the meat of forest animals.[1]

In July the cool rains of the monsoon in combination with a weakened digestive fire and other conditions lead to imbalance and

---

[1]The <u>Caraka Saṃhitā</u> sets up two contrasting types of habitat: forest (<u>jangal</u>) and marshland (<u>anūpa</u>). There seems to be a contradiction between prescribing rice derived from a marshy habitat but prohibiting the flesh of <u>anūpa</u> animals, such as boar, rhinoceros and buffalo, but <u>vaidyas</u> can no doubt offer some explanation.

CLIMOGRAPH OF ALLAHABAD, UTTAR PRADESH, INDIA

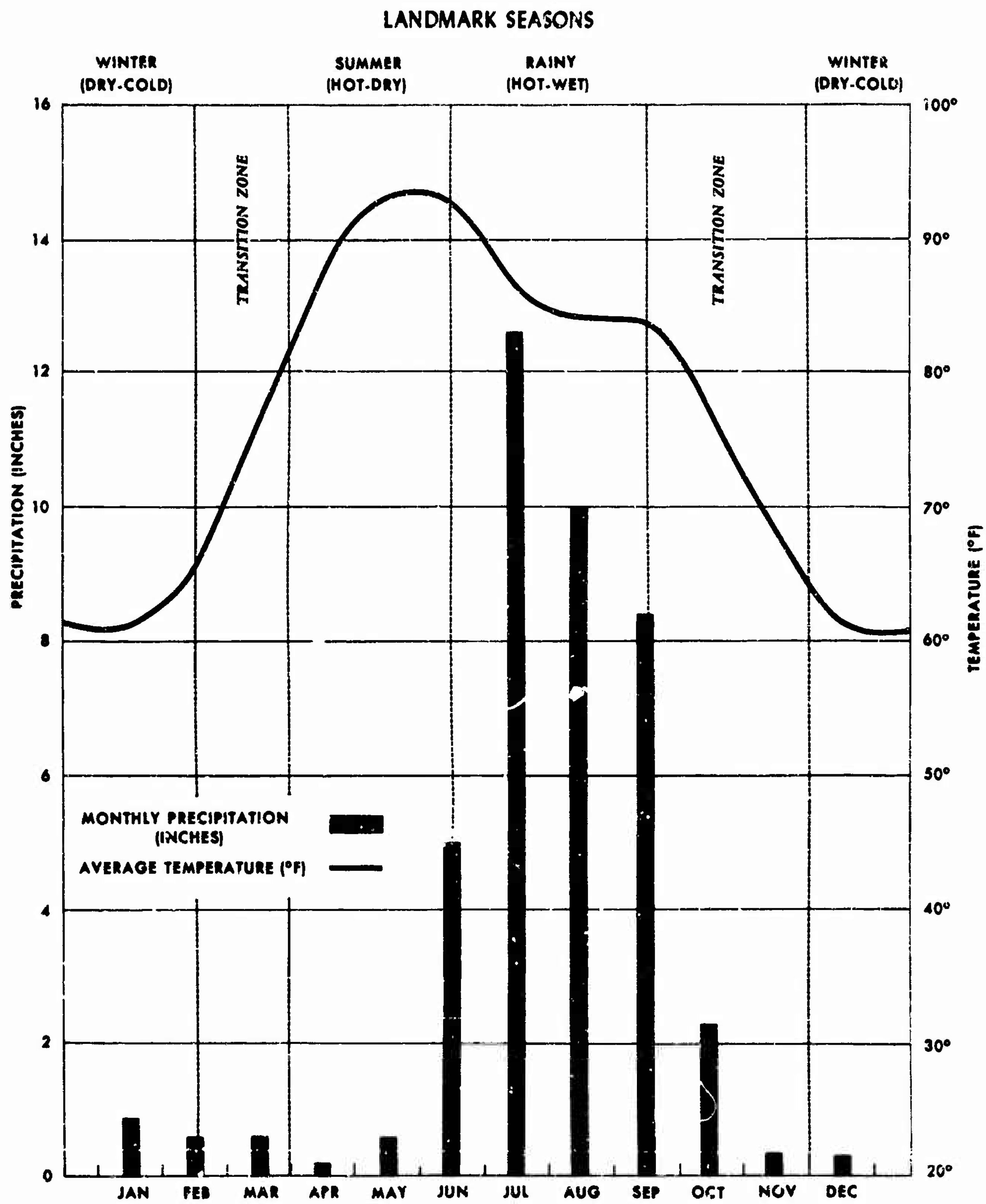

Figure 2. Climograph of Allahabad, Uttar Pradesh, India

diseases appropriate to this time of the year. Ordinary water should not be drunk at all; only the liquid or broth in which pulses have been boiled are to be used. Wine made from honey is also recommended. It is important to follow a strict daily regimen in this season, to try to avoid the extremes of coolness of the rains as well as the sun's rays during gaps in the monsoon. One should try to spend time in dry places and to have dry massage. "Acid","saltish" and "oily" qualities should be sought in food and to build up the gastric fire one should eat barley, wheat and rice which are two or three years old, since old grains are more easily digested than the new crop.

As the monsoon diminishes, the sun's rays in the Moist or Dewy season of September fall through brightly washed skies with a special intensity, upsetting the body which has become habituated and sensitized to the cool monsoon. To counter the specific types of imbalance resulting from this, Caraka recommends blood-letting and purgation and the avoidance of exposure to sun and to easterly winds. Certain "bitter" foods should be used, as well as food and drink that are "light", "sweet" and "cool", as in the summer season. But the water found in rivers, ponds and wells at this time is considered extremely pure, limpid and healthful for drinking, as it is alternately warmed by Sun in the day and cooled by Moon at night.

Except in the summer, daytime sleep causes Kapha ("phlegm") and Pitta ("bile") to be excited. Therefore fatty persons and those of "phlegmatic" constitution should never sleep in the daytime. Kaviratna (1901, pp. 240-1) lists a variety of diseases caused by day sleep. He also notes that, whereas night sleep produces dryness in the system, daytime sleep (unless it occurs in a sitting posture!) leads to oiliness.

There are some incidental references in the literature of ancient India to the methods then popular for protection against high thermal stress: light and loose-fitting clothing, fans, etc. The Chinese Buddhist pilgrim Yuan Chwang or Huien Tsang (600-664 A. D.), writing during the Gupta period, described the provision in cities of forested areas with arbors, which by their coolness seemed to dispel the summer heat. Here were also arrayed porous water jars for drinking purposes, while swimming in ponds and rivers was also popular (Saletore 1943, p. 151). During this and earlier periods the more prosperous social classes at least utilized water in many ways to counteract the hot dry days. Besides artificial lakes, pools and fountains for bathing, the poet Kalidasa described a "water-machine", apparently a sort of revolving sprinkler whose effect was somewhat like that of the sprinklers used to water lawns in modern America. There is also occasional mention, in the homes of princely persons, of subterranean chambers at one end of a bathing pool, cooled by water on all sides (Basham 1963, p. 204).

The ideal principles of ancient Indian village architecture are laid out in the Mānasāra or Silpa Shāstra. This work was compiled about the 5th or 6th century A. D., but it embodies much older traditions, even though Roman influence (Vetruvius) is also discernible. This work recommends that a village site should slope toward the east, with principal streets laid out on an east-west axis to allow purification all day by the sun's rays (Havell 1915, pp. 8-9). The main streets should be intersected by shorter north-south streets for air circulation.[1] Although villages and towns were often ideally laid out according to a religious symbolism (lotus, Swastika, conch, bow, etc.), and the site was considered sacred, the houses in practice usually clustered near water, whether a river, lake or pond (Mukerjee 1940, p. 376).

B. The Muslim-Unani Influence

The first incursions of Islamic armies into northwest India occurred in the 12th century. They were the prelude to a lengthy succession of invasions which brought Muslim rule to North India, through several dynasties ending with the Mughals. Persian and Arabic cultural influences followed the Islamic political hegemony and among these was the Greco-Arabic system of medicine known today as Unani or Unani Tibbiya. In this report only a brief--undeservedly

---

[1]At the central cross-way of a village there should be a large neem, pipal, or mango tree.

brief, to be sure--resume of Unani medicine will be made.[1] While it seems to be primarily derivative from the Aristotle-Hippocrates-Galem humoral theory (the word Unani literally means "Greek"), there is no question that it was also influenced at an early stage by ancient Indian or Ayurvedic ideas. These were synthesized and reinterpreted especially by the Arab physicians and philosophers Rhazes (c. 865-932 A. D.) and Avicenna (980-1037 A. D.), whose various works have long been available in the original and in translation.

Unani recognizes four humors instead of three and its Arabic-language medico-philosophical structural concepts are different and carry their own flavor. But in actual practice, especially in the North Indian milieu, Unani is fundamentally similar or analogous to Ayurveda. Indeed, both Unani and Ayurvedic practitioners in India today nearly always make the statement in conversation that "there isn't any real difference between them".

Like Ayurveda, Unani treats imbalances or excesses, such as those of heat or cold, by an external or internal application of substances having contrary or balancing qualities and effects. In Unani materia medica, for example, sea water is reputed to be "dry", pepper "hot" and roses "cold". It is not surprising that rose water as a cooling drink is especially associated with Muslims and that rose gardens were so much loved by the Mughal rulers.

As decribed by Mujeeb, at least the nobles and more prosperous classes among the Muslim rulers always sought to arrange their houses in an open or airy location, exposed on all sides to the wind, and especially the northern breezes (Mujeeb 1967, p. 371). Large tents were often added to the houses for night-time social functions, but during the hot days men took repose inside the house walls and courtyards, which were supplied with jars and fountains of water. Covered terraces were especially designed for exposure to breezes for sleeping at night, and they opened into a large chamber where the bedstead could be easily moved in case of

[1]Reference sources on Unani medicine include the following: Report of the Committee on Indigenous Systems of Medicine (1948); Afnan 1958; Siddiqi 1959; Leclerc 1960; and Sanyal 1964.

rain or dust storms, or the late night chill.[1]

Some of the adaptations to heat utilized by the early European settlers in India, as described in the next section, were initially borrowed from the Mughals. An often-quoted lament of the first Mughal king, Babur (1483-1530), recorded in his diary, would suggest that he found both the cultural and the climatic environment of India difficult:

> Hindustan is a country of few charms. The people have no good looks; of social intercourse, paying and receiving visits, there is none; of genius and capacity, none; of manners, none; in handicraft and work there is no form or symmetry, method or quality; there are no good horses, no good dogs, no grapes, musk-melons or first-rate fruits, no ice or cold water, no good bread or cooked food in the bazaars, no hot-baths, no colleges, no candles, torches or candlesticks. (Bābur Nāma, p. 191).

But by the time of Akbar's death (1605) a regular system of ice supply from the high Himalayas had been organized, and Abu 'l-Fazl, in the Āin i Akbarī, mentioned that even ordinary people used ice in summer, while the great nobles used it all the year round (Moreland 1920, p.257).[2] In addition to ice, various techniques of evaporative cooling and the chilling of liquids by saltpetre were also known to and used by well-to-do persons, at least. Only one Mughal practice appears not to have been widely accepted by later European settlers: the tahkhānā or underground room described by Bernier and other European visitors to the Delhi court. This subterraneous apartment was furnished with large fans; however, more of the Mughal nobles probably favored a khaskhānā, or room evaporatively cooled by walls and roof of khas.

So far as typical dress during the Mughal era is concerned, the literature is rather contradictory. Moreland says that

---

[1]Many Anglo-Indian and present-day Indian houses of well-to-do persons continue this architectural feature: a room on the roof where beds may be moved when the elements disturb the night's sleep.

[2]The very high price that was quoted at that time (one rupee per pound of ice) would seem to have excluded all except the wealthy, however.

descriptions of North Indian clothing at the time of Akbar's death generally picture people as naked from the waist up, while writings of that time make no mention of the use of woolen garments, blankets or turbans (Moreland 1920, p. 276). But Chopra claims that even the poorest people always wore turbans to protect the head from heat and cold.

> Bare-headed persons were little respected in medieval India, and people invariably put on a cap or a turban while stirring out of their houses. (Chopra 1963, p. 8)

It must be left to competent historians to decide where the truth lies in this matter.

Chopra particularly emphasizes the importance in the medieval Indian diet of sweetmeats, for both milk and sugar were very plentiful in those days. One has the impression that these milk-and-sugar sweets, of the same type that are still in North Indian halvai shops today, were almost a staple food. Thus, the French traveler Tavernier reported that

> Workmen return from business and according to the custom they make no supper, they eat some sweetmeats and drink a glass of water. (Chopra 1963, p. 35)

Another visitor, Della Valle, concluded simply that the Hindus lived on butter, cheese, milk, bread and sweetmeats, and early European travelers were overwhelmed by the sight of whole bazaars with no other shop but sweetmeat sellers (Ibid., p. 36).

C. Anglo-India

The final alien minority who were to rule India arrived first as "factors" and "writers" or officials of the East India Company and were largely a male society until around 1835, when the Suez Canal was opened and English women began to arrive in Hindustan in greater numbers. The uncertain jurisdiction of "John Company" over the Gangetic plain was succeeded in 1858 by the British Raj.

Social historians of Anglo-Indian[1] life and customs describe a gradual evolution from 1700 up to World War II. In relation to environmental adaptation and protection too such successive innovations as the railroads and electric power were important landmarks of technological change. However, the following glimpse into an interesting and nearly-vanished chapter in the history of human adaptation to heat in North India will focus mainly on mid-19th century Anglo-India, a time immortalized by scores of sharp-eyed chroniclers from Fanny Parkes to Rudyard Kipling. According to Rao, the hot Indian climate was a consistent theme or backdrop in Anglo-Indian novels and literature from the earliest to the last, and tended to lay a melancholy shadow over them. For Kipling, the best-known Anglo-Indian author, the almost unendurable heat became

> . . . a sinister force, an evil character, destroying his countrymen and making India the "grim step mother," "the land of regrets". (Rao 1967, p. 59)

As Greenberger has recently put it,

> . . . the basic image of the climate of the country was one of fantastic heat. A climate in which it would be difficult for any Briton to work up to his capacity--this was India. (Greenberger 1969, p. 40)

1. Housing and Cooling Devices

According to Spencer and Thomas, the first ventures of Europeans into the world of tropical Asian living, from the 1500's onward, were marked by an appalling naiveté:

> The wearing of wool, the eating of heavy, high-calorie meals, and the building of tight, airless houses were practiced by the Portugese, the Dutch, the British, and the French from the sixteenth century well into the nineteenth. Knowledge of

---

[1]The modern referent of this term in India is different--it is the Anglicized Christian Eurasian minority but here it will be used in its 19th century meaning: the British colonial society in India.

sanitation and medicine was, of course, no more advanced than knowledge of climate . . . . The average reaction to the properties of air during the 16th, 17th, and 18th centuries was to try to shut it out at night while one slept, by closing tight all the windows and doors, on the theory that foul night air somehow induced fevers, aches, and pains. (Spencer and Thomas 1948, p. 639)

This idea, so far as night sleep is concerned, may have had some early currency among Europeans in India. But when Englishmen in the employ of the East India Company first settled in Calcutta and Madras in the early 18th century they usually built grand two-storied houses in the accepted European fashion. These residences included lofty classical piazzas which were airy and shady at mid-day but let in the sun's rays too easily in the early afternoon. According to Spear, it was only at the end of the 18th century that the coolness of ground floor rooms was discovered by the British in Bengal (Spear 1932, p. 49). It was at about this time too that Venetian blinds were introduced for windows. Only a few houses had them in 1770, but by 1800 they were universal.

In the 18th century the term "bungalow" meant a temporary and one-storied thatched building. Soon, however, the British were building new, and altogether much more magnificent, bungalows as their residences. According to a principal historian of this architectural genre, the Anglo-Indian bungalow may have been largely derived from an old Bengali type of dwelling, the "double-roofed house" (Nilsson 1967, p. 129). This name refers to the practice, at least in the more primitive versions, of hiding the sloping roofs by putting up an artificial interior ceiling of white cloth.[1] In their more evolved form, the Anglo-Indian

---

[1]This same device was used to good effect by anthropologists, including the author, living in a typical village house in eastern U. P. in 1953. On one notable occasion the sturdy cloth ceiling failed to prevent the numbing impact onto the middle of our table at meal time of an enormous, highly-colored and rather poisonous myriapod, but for the most part it placed a reassuring shield between the dusty and infested roof rafters above and the human occupants below.

bungalows were formed with high ceilings and spacious but lowered verandahs, providing more shade than the high piazzas. The roofs might be of a thick layer of thatch, or of tile. The former predominated before the 1857 Mutiny, especially in "the Mofussil" (muphassal, the towns and districts far removed from major urban centers such as Calcutta or Bombay). Thatch kept inside temperatures lower at night, but were likely to harbor snakes, arthropods and other creatures, were more vulnerable to fire, had to be replaced more frequently, and gave off an unpleasant odor in the rainy season.

British settlement in Benares (now Varanasi) in the late 18th century, for an account of which we are obligated to B. S. Cohn, was generally representative of that throughout North India. Here the European community--East India Company officials, civil servants, military officers, planters, etc.--established themselves at some distance from the old Indian city, where land was not at a premium. In addition,

> A new area made it possible for a house to be built to receive air on all four sides--an important consideration in the Indian climate. (Cohn 1962, p. 182)

To this day those spacious areas in Indian cities where the Anglo-Indian community built their bungalows are variously designated as the "Cantonment", the "Civil Lines", etc. (Planalp 1958, pp. 250-1). Some of the hordes of servants and hangers-on of the Englishmen also settled nearby. It is Cohn's conclusion that

> The houses which the British built in Benares, and throughout much of North India, resembled county seats of the English gentry adapted to Indian conditions. The British tried manfully to create English country gardens around their homes. (Cohn 1962, p. 183)

The Anglo-Indians made much use of a home-cooling device known in India since Mughal times, and probably much before (Hodivala 1939, p. 678). This was the "tattie" or "tatty" (tattī), a screen perhaps two to four inches thick made from plant fibers, mostly from the long, stiff bristly roots of the "khuskhus" (khaskhas or simply khas), a plant (Andropogon muricatus) growing plentifully in the jungles and moist wastelands of North India, especially along river banks. These sponge-like roots were woven or tied closely together tier upon tier, within a frame sized to fit windows or doors, especially on the west side, the direction of the prevailing wind (Ashby 1937, p. 154). When water was poured over the screen, and especially if there was some wind to set up a cross-ventilation through the room, the "khuskhus" screen lowered the inside temperature markedly.

> By this simple contrivance, the fall of temperature due to the evaporation produced by a current of hot dry air passing over the grass was so considerable that in May, in Oude, with a west wind, the thermometer stood in the shade at 104°, in the house at 83°, and behind the tattie at 68°. (Fayrer 1884, p. 923)

In addition, khas gave off a very pleasant and refreshing scent. Emma Roberts reported in 1837--before the construction of railroads in India--that those women who were required to travel by palanquin in the summer sometimes fitted the palanquin with tatties; she advised against this step, however, due to the difficulty and expense of hiring men to supply and pour water and the fact that

> . . . as the air is made damp but not cool, . . . fever or exhaustion is the result. (Roberts 1837, Vol. I, p. 169)

Another hot-weather device which gained widespread use at the end of the 18th century was the swinging "punkah" (from Hind. pankhā, or "large fan"). The earliest mention of its use was by Hickey in 1785, and it was said (probably facetiously) to have been invented by a Eurasian clerk as an improvement over his first attempts to ameliorate the sweltering conditions in his office by having his desk and chair suspended from the ceiling and swung back and forth to obtain a little air movement. However, Col. Yule in Hobson-Jobson claims that the punkah was known to the Arabs, having been invented by Caliph Mansur (753 - 774 A. D.). At any rate, the Mughals in India do not appear to have known or used the swinging punkah, and chroniclers of Warren Hastings' era (1772-1784) mentioned only "boys with flippers and fans" (Dewar 1922, p. 105).

The punkah passed through nearly a human lifetime of evolution and elaboration, best described by Dewar (Ibid., pp. 104-110).

At first it was a solid frame of light wood, from 4 to 10 ft. in width and up to 6 ft. in depth, hanging close to the ceiling and suspended by up to six cords each a foot long, attached to big hooks in the beams above. One or more servants stood inside the room, swinging the punkah back and forth by means of pulling ropes attached to the two ends. Until at least 1810 punkahs were used only in dining rooms; thereafter they came into use in drawing rooms and bedrooms also. Another early development was the device of passing the pulling cord through a hole in the wall, so the "punkahburdar" or servant could carry on his work while languishing on the outside verandah. (Punkah-pulling, incidentally, provided a good job for blind persons.) Sometimes a piece was cut out of the punkah so it could swing through the great chandeliers that adorned some of the finest houses.

The early punkahs of "people of refined taste" were decorated by paintings or pictures, and others were covered by colored cloth. However, it was soon discovered that a reduction in depth of the punkah frame and the addition instead of a flounce or vallance would provide a better movement of air. According to "An Anglo-Indian",

> Punkahs spoil the looks of a room but are necessary evils . . . . The vallance is put on full, and is made of some white or ecru washing material; it can be edged with a bind of the colour prevailing in the room. (An Anglo-Indian 1882, p. 63)

By 1850 the punkah no longer hung close to the ceiling, but rather was suspended by long ropes. Frill and frame continued to be of equal breadth until even later, but by the time the first electric fans began to appear in India the frame of the "modern" punkah of the time had virtually

> . . .shrunk to a pole to which the all-important frill is attached. (Dewar 1922, p. 110)

There may have developed, however, some tendency to regional divergence in punkah type, since a turn-of-the-century publication opined that

> The Bombay and Bengal punkahs consist often of a bar of polished wood, from which the fringe hangs. This is prettier and cleaner, but it hardly gives

> so much wind as the broad, flat frames. (Steel and Gardiner 1902, p. 201)

These authorities further noted that the punkah frames are usually whitewashed, and after several coats the lime comes off in flakes and gets into one's eyes. As a matter of fact, the authors of The Complete Indian Housekeeper indelibly recorded their exasperation at this questionable boon to human comfort:

> There is nothing more difficult than to judge the height at which a punkah should be hung. Strictly speaking it is always too high or too low; in other words, it either scrapes your head or leaves you perspiring. In fact, at its best it is an instrument of torture. (Ibid., p. 201)

They concluded that punkahs are a necessity at meal-times, but otherwise are of comparatively little use except to keep away mosquitoes, or when sleepingon the roof.[1]

By 1850 a punkah wheel or pulley was in use, and later a "punkah-pulling machine" (not further described) was developed and used in a few government offices. Dewar notes, however, that it was unwieldy, noisy, and prone to frequent breakdown (Dewar 1922, p. 110)

Both the "soft, slow swish" and the "moaning" of the punkah were characteristic sounds in the old Anglo-Indian bungalow (Cust 1881, p. 92). Indeed, if proper attention were not given to oiling, the punkah's moaning and squeaking could become most distracting during the hours of sleep. The Complete Indian Housekeeper recommended black lead or oil, while admitting that

> The latter, however, is apt to smell. (Steel and Gardiner 1902, p. 202)

---

[1] I am unable to say how the punkah could be rigged up on an open roof.

This source also recommended leather thongs as more satisfactory than ropes for use with the punkah, although their initial cost was greater.

The movement of the punkahs was helpful on calm days to draw a current of air through the water-soaked khas tatties. However, its effect was often lost in the spacious drawing rooms of Anglo-Indian homes (often as much as 2000 ft. of floor space, with ceilings more than 20 ft. in height):

> . . . unless the wind blows, the tatties are useless. (Parkes 1850, p. 102)

Therefore a mechanical contrivance for forcing cool air into the house was developed, perhaps by Dr. George Spalsbury, who came out to India in 1823. This was the thermantidote, an enormous hollow monster made of mango wood or of sāl wood. Standing about 7 ft. high, 4 or 5 ft. wide, and 9 or 10 ft. long, it was mounted crudely on iron wheels to make it somewhat movable. It was placed on the verandah with a funnel projecting into a window of the house. On the outside of the thermantidote circular openings about 4 ft. in diameter were fitted with khas tatties, while in the interior of the machine four fans were fixed to a rotating axle, continuously turned by one or two servants by means of an external wheel.

The punkah and thermantidote in combination could generate an awesome flow of air, as one commentator humorously noted:

> A slave grinds away on the verandah at the wheel. Inside the room your hat is likely to be blown off into a corner. There is a corresponding thermantidote on the opposite verandah and a punkah swinging overhead. All that is needed is a current from the ground to be involved in a general hurricane. (Atkinson 1911, n.p.)

Several servants were kept occupied in supplying water to the tatties. The thermantidote, or an improved "self-watering" version, was fitted with perforated troughs which allowed the water to fall continuously upon its khas screens and to collect in tubs underneath, from where a servant again carried it in a jar to the top of the device.[1]

Indeed, the use of the cooling technology in 19th century Anglo-India was dependent upon the massive exploitation of indigenous labor. Lists of servants required be a British family in India in the days of the Company total from 30 to 110. Mrs. Parkes' list, which is typical, shows six "punkahburdars", while she notes that

> . . . 12 or 14 extra coolies are necessary if you have more than one thermantidote or if you keep it going all night as well as during the day. (Parkes 1850, p. 210)

Trevelyan has a passage which nicely captures that sense of

> . . . the secure plenty and languid ease of a European household in India. In spacious saloons, alive with swinging punkahs; where closed and darkened windows excluded the heated atmosphere, and produced a counterfeit night, while through a mass of wetted grass povred a stream of artificial air; with piles of ice, and troops of servants, and the magazine of the preceding month . . . (Trevelyan 1894, p. 122)

Even in the rather more modest establishments maintained by Mrs. Ashby's family in Bihar in the 1880's, four of their 13 servants were exclusively "punkah-coolies", accounting for Rs. 32 of the monthly servant expenditure of Rs. 104. These men worked in four-hour shifts day and night (Ashby 1937, pp. 28-29).

The Anglo-Indian house or bungalow was made endurable in the hot dry summer especially by tatties, and in the sultry monsoon especially by punkahs. But according to Harriette Ashmore, even with these cooling contrivances,

---

[1]A house fitted with three of these machines, operating day and night, kept the inside temperature under 85° F. in the hottest days, making it a refuge for many people in the community (Steel and Gardiner 1902, p. 200). These authors disagreed with those people--a sizeable minority, apparently--who believed the thermantidote to be unwholesome and provocative of "climatic disease".

From the month of April to the setting in of the cold season, except occasionally during the rains, the entire bungalow is closed from the hour of rising to the setting of the sun. Not a breath of external air must intrude. (Ashmore 1841, p. 223)

The observation accords with that of a former Punjab resident:

Thus the house of a European is more like a gloomy prison than an ordinary dwelling house. (Kendrew 1927, p. 127)

One last environmental adaptation highly characteristic of the old one-storeyed Anglo-Indian bungalow should be mentioned, one which allowed the European family to take better advantage of night-time cooling. This was the construction of a "chabutra" (cabūtarā), a raised, usually circular, platform of cement over brick, built some two feet high, and erected 15 or 20 ft. from the bungalow (Fayrer 1884, p. 925). It constituted, in effect, a kind of detached porch for open-air use.

Lolling there in wicker chairs, the family spent the warm evenings in desultory conversation. Its few feet elevation from the ground is an absolute necessity for protective comfort; the nocturnal hours bring out hosts of crawling creatures which hide from the sun's scorching rays during the day: scorpions, centipedes, lizards, caterpillars, beetles, and snakes. (Ashby 1937, p. 140)

In very hot weather the English families slept on the cabūtarā, although a wire fence might be set up on its rim in areas where larger jungle animals were a threat (Ibid., p. 239).

2. Clothing

With respect to clothing, English men and women in India were seemingly often torn between the impulse for comfort and the sometimes rigid prescriptions of their own traditions, suitable to a much colder climate. Thus, while council members in Calcutta early took to wearing light muslin Indian-style clothes in their crowded, stifling offices, at formal meetings they were expected to don their finest broadcloth coats and wigs (Barber 1965, p. 53). When moving outdoors they employed "roundel boys" to carry their roundels or umbrellas (Ibid., p. 91)

The full history of the evolution of Anglo-Indian clothing adaptations to the hot summer and humid monsoon seasons of India has yet to be written. There appear to have been large variations from place to place, from time to time (changing fashions), and between one segment of Anglo-Indian society and another. For example, different Army units followed different formal and informal dress traditions. However, one historian of the period noted that it was the "griffins", the newcomers to India, who adhered most slavishly to the European mode of dress, whereas those who had been longer in India generally adopted relatively casual light-weight and loose-fitting garb, more or less modeled after the native Indian dress, at least in their domestic and informal life (Renbourn 1963, p. 200). Similarly, it was often remarked in the days of the Company that the farther one traveled into the interior and away from such centers as Calcutta and Madras the more "Indianized" one found the English residents in their manner of life and dress.

At the same time, in a reaction that is not untypical in the history of colonialism, many of the educated Indians who assumed positions of authority under British rule outdid their overlords in their "stuffiness" of manner and dress. Sir George McRobert has described how in Madras the University Chancellor at the hottest time of day in August wore a dark morning suit under red flannel doctor's robes while giving diplomas to graduates who also wore dark suits and black robes. And High Court judges also customarily sat from 11 a.m. to 5 p.m. on the hottest days wearing the judicial robes and wig of the King's Bench Division in London, while the Indian counsel also wore the prescribed black gown and stiff bands (Crowden 1949, pp. 337-8). Even tody, one can always spot the lawyers in the vicinity of any district or local court building by their heavy, close-fitting black tunics.

Protection of the head from solar radiation was largely accomplished by the Mughals through the use of turbans and umbrellas (woven of reed or bamboo). The early Company officials and their wives used a variety of headwear, especially of the broad-brimmed variety, but were so assiduous in the wearing that the Indian natives' nickname for the Englishmen was "hat-wearer" (topīvālā). The Anglo-Indian head-covering par excellence was the "sola (or solar) topi", whose history Renbourn has so exhaustively documented (Renbourn 1962a). The sola topi originally took its name from the solā plant (Aeschynomene paludra), a lofty Indian bush whose pitch or bark, cut into thin layers and pasted together, was first used in making the hat. The sola topi, with its distinctive characteristics of providing a thick insulation over the head together with a moderate brim, was elaborated in a number of styles after its introduction around 1840. It enjoyed wide but not universal acceptance: most of the ladies found it lacking in grace, and it tended to be fragile and easily damaged by rain (Beatson 1857, p. 625). The military authorities never agreed fully on which headgear or combination of headgear best met such diverse requirements as comfort (asleep as well as awake), protection from sword cuts, and protection from sun and heat. However, the sola topi eventually became the most widely used type of hot weather headwear, at least for civil officials who had to move about in the sun. Many British Army units adopted white cap covers and neck curtains, which were called "havelocks" after General Havelock (Renbourn 1956, p. 219). Fayrer recommended that one bind around a light "puggree" (pagarī, a turban or at least a length of porous cloth to be wrapped on the head) at the juncture of the hat rim and the head, with a strip hanging down to cover the neck (Fayrer 1884, p. 943). Experienced topi-wearers also followed the practice of putting fresh green leaves or a moistened pad inside the hat, and of wetting the puggree.

Renbourn has clearly shown how incomplete and contradictory was the best medical authority during the last century with regard to thermoregulatory physiology and clothing biophysics (Renbourn 1956, 1962a, 1962b, 1963). Well into the 1900's field medical authorities conceived that the principal danger from the exposure to sun in the tropics was not heat, but rather the presumed "actinic" or chemical rays in sunlight (Renbourn 1962b, p. 94). Heatstroke took an enormous toll, especially in the Sepoy Mutiny of 1857. Collier writes that

> On May 27 the Horse Artillery had left Meerut stifling in brass helmets, tiger-skin rolls, cloth dress jackets with high red collars, leather breeches and high jack-boots. (Collier 1964, p. 82)

Only the unorthodoxy of their commander, who ordered them to rip off their collars, saved them from severe heat casualties. But later the tendency of their men to march in shirt sleeves, and to avoid unnecessary exertion, was a frequent complaint of British Army officers (Kincaid 1938, p. 188).

The Victorian naval uniform during the hottest season in the Persian Gulf consisted of thick underwear, topi, high-neck collar, and spine-pad. This last lingered on vestigially for years in the form of an extra strip of material sewn into the rating's shirt (Critchley 1946, p. 104).

> Spinal pads 9 in. wide were necessary for the protection of the spinal cord from the sun's rays. (Willcox 1920, pp. 394-5).

The spine pad, intended like the topi to protect an especially sensitive part of the anatomy from the imaginery danger of solar actinic rays, was very widely used in 19th century Anglo-India, especially by the British troops.[1]

> The head and spine should be effectively protected; the level rays of the sun at morn or eve are often more dangerous than the vertical. (Royal Geographical Society, Hints to Travellers [1889], quoted by Wulsin 1953, p. 117)

---

[1]While Renbourn felt confident in pronouncing a death verdict on the spine pad in 1956 ("Spine protection is no longer a subject for discussion amongst students of climatic physiology"), it now appears that the matter may not be altogether closed, for R. F. Goldman has told me of recent research by J. D. Hardy at the John B. Pierce Foundation Laboratory in New Haven, Conn. that is indicative of the possible existence of extra-cerebral thermal receptors along the spinal cord which are sensitive to temperature increments such as those resulting from solar radiation (Goldman 1970).

The civilian as well as the military Anglo-Indian male dress continued to feature tight trousers and heavy rolled collars well into the 19th century. This "overdress" in the tropics, especially the use of flannels and woolens at night,[1] was largely founded on the fear of miasmata, of chill, of the "dry bellyache", etc.[2] The Royal Geographical Society, in its 1889 edition of Hints to Travellers, noted that clothing in the tropics should, above all, keep the body at an equable temperature day and night. As the "most effective non-conducive and absorbent material", flannel was the most highly recommended fabric, unless the presence of prickly heat dictated a fine, porous silk (Wulsin 1953, p. 116).

> At all times light flannel specially made should be worn next to the skin. Over this, it is also better to wear tweeds, such as are manufactured for hot climates, rather than cotton fabrics. (Fayrer 1884, p. 921)

The high incidence of fever in 19th century Anglo-India was frequently ascribed to "chills" and to the drop in temperature after sundown, although in reality the cause was usually malaria. These beliefs are also reflected in the cult of the "cholera belt"--a strip of flannel commonly worn around the waist by Anglo-Indians in the 19th century as a protection against "derangement of the digestive organs"; or against infective enteritis in its various forms.

---

[1]Also, "Flannel because of its 'irritating spicules' was believed to encourage skin breathing," (Renbourn 1963, p. 197), and for this reason flannel was often worn next to the skin, although the outer clothing was light and loose.

[2]In 1788 Lind described a condition, called "barbiers", and known to Indians and British alike. It was a kind of paralysis believed to be derived from sleeping in the open air exposed to winds. The Indians, at least, are said to have treated it by digging a hole in sand and burying the patient in the middle of the day up to his neck as long as he could endure the heat (Lind 1788, pp. 272-3).

3. Daily Regimen

For the millions of English soldiers and civil servants in India during the two centuries of British hegemony, extended summer vacations at a cool hill station were more the exception than the rule. Women and the few children who were not left in school in England might spend the hot days at one of the fashionable mountain resorts, but their husbands generally remained sweltering at their posts in the plains, at least during the 1800's. However, by 1838 the Governor-General and his staff had made Simla their capital from March until July (Spencer and Thomas 1948, p. 641). The government of the United Provinces (now Uttar Pradesh) moved to Naini Tal, and in other states there was similar regard shown for the comforts of the topmost echelon of government. On the plains the only official concession made to the fierce summer heat was a slight reduction in working hours in most offices, which opened an hour or two earlier between April and September and often closed at about noon. This was the time of which Kipling wrote:

> There are six other months when none ever come to call, and the thermometer walks inch by inch up to the top of the glass, and the office is darkened to just above reading light, and the press-machines are red hot to touch, and nobody writes anything but accounts of amusements in the hill-stations or obituary notices. (Kipling 1898, p. 94)

With respect to Anglo-Indian domestic life, however, much attention was given to the problem of preserving health and efficiency in the heat. Old-timers advised stern self-discipline and a firm refusal to succumb to inevitable feelings of lassitude and lethargy (Huggins 1824, p. 103). According to them, one should take daily exercise during the morning hours and

> . . . employ the mind, if not the body, actively--read, write, draw, keep records, . . . do anything, as long as you do not give in and go to bed and sleep, because if you do that you are nearly certain to end by being ill, and becoming a nuisance not only to yourself but to your friends. (An Anglo-Indian 1882, p. 74)

During the hottest season on the Indian plains the English residents found that exercise was tolerable only during the early morning or the evening hours. Some followed the practice of arising as early as 4 a.m. for a morning ride. "An Anglo-Indian" noted that by 7 a.m. the sun begins to be troublesome (Ibid., p. 74). Nightly minimum temperatures above 92° F. were (and are) not unknown, and on May 4, 1857 the 9 a.m. temperature was 106° F.

Upon arising, whether at the break of dawn or later, the 19th century Anglo-Indian took chotā hazrī or "small breakfast", essentially tea with "biscuit" or fruit. Then followed the early morning ride:

> . . . the young gentlemen, as soon after their arrival as they can, muster money to buy a horse . . . (Brown 1948, p. 114)

> Of all forms of exercise, none equals riding on a smart, cheerful, and springy Arab or Australian horse . . . . there is never the feeling of wearisome monotony attending Anglo-Indian pedestrianism. (Fayrer 1884, p. 930)

> . . . there is reason to believe that the higher stratum of air utilized on horseback and the current created in centering, galloping, or trotting are highly beneficial. (Ibid., p. 930)[1]

---

[1]Dr. Fayrer's explanation has been borne out by a modern microclimatic study in India showing the maximum dry bulb temperature at 6 ft. to be 8.8 F. lower than than at ground surface level in an open field (Sreenivasan and Ramabhadran 1950, p. 39). Incidentally, it is interesting to observe that her enjoyment of an early morning ride is but one illustration of how Mrs. Galbraith, the American ambassador's wife, has recorded spending her hot-season Indian days in ways which are very reminiscent of those of the British ladies in India a hundred years earlier (Galbraith 1969, p. 530).

Afterwards, those with enough leisure might sometimes go back to bed for a few more winks, but Mrs. Parkes noted that rheumatic fever and lumbago might be caused by standing or sleeping before the thermantidote after coming in from a pre-dawn canter (Parkes 1850, p. 208).

A substantial meal was enjoyed somewhere between 8 and 10 o'clock. Appetites suffered greatly during the summer season and

> . . . as a rule, in the hot weather this is the one repast eaten with appetite during the whole day. (An Anglo-Indian 1882, p. 73)

The breakfast typically consisted of fish, eggs, toast, fruit, jam, etc. As often as not, in the hot season at least, the working day ended by noon or at least by 2 or 3 o'clock, at which time the Anglo-Indian ate "tiffin" or lunch. In the summer this was usually a light meal of cold or potted meats, fruit, cheese and cakes. Despite their being disapproved by many old-timers, afternoon naps often followed the tiffin in hot weather.[1] At about 5 o'clock tea or else some iced liquid repast was enjoyed, and the dinner hour was a variable one. In some cases it was set as early as 7 p.m., to allow time to drive or ride in the cool of the evening, while in other cases it was observed at a relatively late hour.

Many accounts exist of the sumptuous and lavish meals enjoyed daily by Anglo-Indians, especially in the days of the East India

---

[1]For today's temperate-zone sojourners in North India's hot season who still may be unable to enjoy the benefits of an air-conditioned bedroom, the majority medical opinion seems to favor napping, but only briefly, for ". . . the siesta, if it amounts to more than a short post-prandial rest of twenty minutes or half an hour, frequently leaves one more tired than one would have been without it." (Ellis 1953, p. 25).

Company,[1] quite out of keeping with the requirements of the climate and probably a contributing factor to more than one case of "apoplexy". Acland wrote in December 1847 that

> . . . Europeans are all of a deadly white, and most of them exceedingly fat. (Acland 1847, p. 32)

But such observations may be exaggerated, and Brown cautions that while

> The appalling appetites of our forefathers--and indeed our foremothers--will be sufficiently demonstrated, . . . it is well to remember that only a fraction of what appeared on the table was actually consumed; the rest was waste. (Brown 1948 , p. 49)

There is probably more than a grain of truth in Fales' report:

> . . . I learn that the big men break down, as a rule, and that the survivors who spend many years in India are, like Lord Roberts, the little fellows. (Fales 1907, p. 590)

Those who are inclined to link the high mortality among 18th century Anglo-Indians with their uninhibited food habits may well pay particular attention to the role of alcohol. About 1800 a man considered "very abstemious with wine" drank four or five glasses at dinner and about a pint of claret thereafter (Spear 1932, p. 88). Captain Williamson's Vade Mecum in fact recommended about this same daily ration of Madeira to the griffin. When this was regarded as standard of plain and simple living, one can imagine the degree of heavy drinking that existed, especially among army troops.

---

[1]At this time the Company's servants had fifteen courses for both dinner and supper, and "The unhealthfulness of a heavy meat diet and of gargantuan meals in the heat of the day seems never to have been suspected, or if so, was obstinately disregarded." (Spear 1932, p. 18)

Of course, the daily Anglo-Indian routine varied considerably depending upon season, occupation, age, sex, place of residence, historical period, etc. Many "typical" resumés could be cited, such as that of "M. A. T.":

> The life of an ordinary Englishwoman out there is more or less wasted, and her daily life is something like this: In the morning, on getting up, perhaps a ride, walk, or some games of Badminton, then home for bath and breakfast; then perhaps an hour or so in copying the butler's accounts and correspondence; now the midday visitors may be expected, so an attitude of expectancy in the drawing-room, with a novel from that Station library; after this, at about two o'clock, a siesta, from which the memsa'b gets up for her five o'clock tea, and to drive to the band-stand, or to play tennis, or some such social gathering, till night sets in, when dinner, a little touch on the piano, and so to bed. (M. A. T. 1886, p. 374)

It may be of particular interest to note that in the period up to about 1780 the time of the principal meal--the "dinner hour"--was in the early afternoon, about 2 or 3 p.m. Thereafter, for reasons which have not yet been satisfactorily explained, the dinner time gradually grew later, moving to 6 or 7 p.m. by 1800, and subsequently reaching the hour of 8 or 9 p.m., where on average it remained. While it is tempting to view this modification of meal regimen as a remarkably slow but natural adaptation to a hot climate, it is possible that other factors in the whole life-situation of late 18th century Anglo-Indians were the more critical ones. For example, Lord Wellesly set a personal example of working in his office during the hot part of the day, leaving the evening entirely for relaxation since, as he said,

> "No constitution here can bear the sun in the middle of the day at any season of the year, nor the labour of business in the evening. After dinner, therefore, nobody attempts to write or read, and, in general it is thought necessary to avoid even meetings on subjects of business at that time . . ." (Lord Wellesly, quoted in Spear 1932, p. 96)

One interesting and rather surprising custom in classic Anglo-Indian society was the obligation placed on newcomers to an Indian station to initiate formal courtesy calls, just the reverse of the custom at home in Britain. Not only this, but these first visits (although not subsequent ones) were made between noon and 2 p.m., at the time of maximum heat discomfort. This soon led to a famous Anglo-Indian institution, the "Not-at-Home Bokkus (Box)":

> At Government House at the end of the verandah, there is a Visitor's Book, but elsewhere the usual custom prevails. That is, nailed to the gateway of each bungalow is a little box with "Not at Home" painted on it. The new comer has to drive round and deposit his or her cards therein, a very lengthy and tiresome proceeding. (Lawrence n.d., p. 208)

However, in typical Anglo-Indian style this irksome duty was also frequently charged to a servant.

Many of the British stations in North India contained public "watering-places" or swimming baths. In the typical station immortalized by Atkinson this bath was for males only, and was located in a one-room bungalow (Atkinson 1911, n.p.). However, some families also had swimming-baths built in their hourses; one mentioned by Mrs. Parkes measured 30 by 21 ft. (Parkes 1850, p. 208). The preferred time to use these watering-places was in the later afternoon.

Numerous accounts describe the difficulties in obtaining satisfactory rest at night in India:

> The intense heat, and the quantity of bad air which necessarily accumulates under the curtains, cause continual headaches and oppression of the lungs. (Acland 1847, p. 123)

> . . . here the heat at night is scarcely endurable, and to sleep almost impossible. (Parkes 1850, p. 84)

> But though [by having the house hermetically closed except at night] we keep it down to 92° in the day, we cannot get it cooler even at night, and that is what makes it so wearing, that you <u>never</u> get any respite from the heat. (King 1884, p. 106)

For sleeping during the summer season the Anglo-Indian gentlemen and ladies had the choice of bedroom, verandah or outside grounds. In all three alternatives the prevalance of mosquitoes dictated either a net or a punkah with a vallance attached so as virtually to sweep the sleepers' faces. The punkah bearers squatted on the outside verandah, separated by a chintz curtain. On those occasional sultry nights when the outside temperature remained around 95°, sleep was hardly possible either inside or outside the house and the

> . . . perpetual poppings of soda-water corks keep up a heavy file-fire throughout the night. (Atkinson 1911, p.p.)

Mosquitoes, crawling venomous creatures, prowling contentious dogs, hot winds and fierce dust storms were all inimical to restful sleep for those who preferred to move their bedding outside in order to escape the suffocating rooms. These conditions are little changed today, as two comments, reflecting experiences separated by almost a century, on another enemy of slumber in India--noisy birds--indicate:

> The raucous cries of the ever present crows, whose cacophony unpleasantly greet every Indian dawn, aroused us at the first light of day. (Ashby 1937, p. 47)

> . . . the birds . . . in this nonviolent land are almost totally unfrightened. They are incredibly controversial--always denouncing each other in the most raucous and angry tones. Indian birds rarely twitter and never sing; instead they challenge and scream. (Galbraith 1969, p. 72)

4. Water and Ice

The early officers of the British East India Company, like everyone else, refreshed their parched palates in the hot days with water that was cooled evaporatively in porous earthenware jars, in the way it is still done throughout North India. In those early days when neither soda water nor ice was manufactured in India, Company officials had among their numerous servants an indispensable ābdār or water-bearer, whose task it was to collect, cool and purify the water. (Purification was by straining, spreading alum and very fine sand over the surface, plunging a red-hot iron into it, etc.) It is recorded that in Calcutta at this time no man trusted another's ābdār, and when invited out for dinner he would always bring his own servant with a jar of water (Dewar 1920, p. 45).

Actually, other methods of cooling liquids besides ice had been known in India for some time. These included ammonia and saltpetre. The solution in water of ammonia, obtained from brick kilns, caused its temperature to fall by several degrees (Balfour 1885, Vol. I, p. 93). The discovery of saltpetre--along with that of the khas tatty and a host of other amenities--was attributed to the illustrious emperor Akbar by his faithful biographer Abu 'l-Fazl (Āīn i Akbarī, Vol. I, p. 60). Akbar's formula was one part of saltpetre to two parts of water, in which a closed container of the liquid refreshment could be left to cool. The method was apparently adopted by the British in India as well (Acland 1847, p. 139).

Incidentally, the attitude toward ice and cold water in India contrast sharply with those reported in parts of the U. S. A. at the same time. Coates has described how cautions against sudden death from over-drinking of cold water in the summer were posted by order of the Humane Society on the water pumps for public use throughout Philadelphia in the 1810-1820 period. And when ice first became abundant and cheap in the same city the newspapers were full of fears and dire warnings about the danger to health of ice (Coates 1858, pp. 235-6).

In North India about 1830 an ingenious locally-known method of producing ice in winter was improved upon and exploited to the extent that the ice could be stored into summer. This required considerable labor, provided as always by the seemingly inexhaustible supply of native workers, who received immediate payment in the form of a few cowries (Ashmore 1841, p. 302). During the winter season an "ice-field" was prepared containing hundreds of shallow beds about 6 ft. square and a cubit in depth, with raised paths between them. In December a black-looking straw of rice, millet, or sugar cane was spread to a foot in depth in these pits, and shallow pans were in turn placed on the straw. Ice formed, to a depth of about 1 1/2 inches, whenever the night was sufficiently cold, still and frosty. The straw of course served to insulate the water from the earth, and had to be kept perfectly dry.

An expert native foreman had the responsibility for judging whether or not the meteorological conditions favoring strong night-time radiational cooling would be likely to occur on any given night. If he gave the signal, at about 6 or 7 p.m. hundreds of "coolies" were summoned to fill the shallow pans from large jars of water, each using an earthen dipper attached to the end of a stick. At about 3 a.m. the shivering workers were aroused to collect the ice from the pans and transport it to a specially prepared ice pit. This was broad rather than deep, with a small well at the bottom and a channel leading from it to the outside so that the pit would remain completely dry. The pit was lined with three or four thicknesses of straw mats, and as the ice was dumped into the pit a number of other workers there beat and tamped it into a flat hard mass. Each morning theice was covered with mats and straw, and the whole pit was enclosed under an earthen-walled house with a thickly thatched roof.

According to Fanny Parkes ice-making continued at Allahabad until February 19 and at Kanpur the highest "official" temperature at which ice nevertheless was made was 43° F. During the year Mrs. Parkes was at Allahabad (about 1835?) 120 tons of ice were produced during the winter. In 1878 Mrs. King reported 25 to 30 tons of ice made in one night by 2000 workers, using ". . . acres of ground covered with large shallow earthen saucers" (King 1884, p. 34). The cost of the ice-making at each station was met on a subscription basis and when the ice-house was opened each year about the first of May each subscriber received a regular ration, such as 25 lb. every other day. The supply of ice was likely to last for three or four months. Mrs. Parkes, noted, however, that the ice ration should be weighed upon delivery

> . . . as the coolies often stop in the bazaars, and sell a quantity of it to natives, who are particularly fond of it, the men pretending it has melted away en route. (Parkes 1850, p. 81)

By 1833 Calcutta was being supplied with ice from America, but the transport in quantity of this ice to the "Up Country" had to await the extension of rail lines between Bombay, Calcutta and New Delhi. The American ice, cut from New England lakes in winter, was considered greatly superior to Indian ice, as it was hard and clear and did not dissolve so rapidly. In Calcutta it was retailed at one anna (twopence) per pound.

5. Postcript

In Europe and America the last part of the 19th century witnessed technological advances destined to provide man with vastly greater ability to control his microhabitat, his immediate environment. These were the taming of electric power and the mastery of techniques of mechanical refrigeration and air conditioning. Their benefits were slow to filter to India and even yet have not reached the average man there, but their first beneficiaries were of course the offices and homes of the British ruling group. Wherever electric power became available the overhead ceiling fan quickly replaced the old swinging punkah. In some cases also the *khaskhas* tatties were modified:

> In some places the wind and the wetting process are mechanized, and in more and more of the larger buildings where the dryness of the climate warrants it, use is made of the more modern banks of water sprays operating in motor driven air stream. (Thoburn 1946, p. 121)

Indeed, the electrification of towns and cities, along with other changes of the times, resulted in a notable transformation of the dwellings and way of life of the British sojourners in India. Kincaid has summarized:

> People were more concerned to have electric fans and running water than a noble facade or a grand situation. Flats became fashionable . . . the

> vast old bungalows were in many districts replaced by neat little villas with electricity, telephones and labour-saving devices. (Kincaid 1938, pp. 277-9)

In the 1920's the homes of the colonial administrators were largely provided with air conditioners (Ibid., p. 289).

The final half-century of British rule in India was marked by a trend toward a single less extravagant standard of dress, eliminating the Victorian collars and woolens but at the same time finding embarrassment at the use of Indian dress at home. Lady Lawrence has recorded how, as wife of the Commissioner, she in effect set the style for the wives of her husband's subordinates. On one occasion she did not wear the customary long wrinkly white kid gloves at dinner, since they were hot and expensive. The women of the station were shocked at first by this departure from tradition, but from that time on they thankfully left off wearing them (Lawrence n.d., p. 42). Later British civil servants in India generally wore short-sleeve "bush-shirts", with shorts or cotton trousers, and open shoes or sandals in the hot season. By 1940 the dress on British ships in the tropics was shorts and sandals and nothing else, even on the head (Critchley 1946, p. 104). According to an anecdote related by Stratton, the pith helmet ceased to be an item of dress de rigueur among British troops when, one day in World War II, a new regiment who had not received their topis were drilled anyway in the tropical sun. When, surprisingly, no untoward effects were observed, the army ceased to require wearing of the helmet as solar ray protection (Stratton 1955, p. 37).[1] Eventually the wearing of the pith helmet almost came to be emblematic of membership in the modern "Anglo-Indian" or Eurasian community, although even today a good many local government officials in North India still don the topi whenever they go out "on tour" in villages in the summer.

---

[1]Interestingly enough, however, a French official has stated that heatstroke cases in the French colonies were greatly reduced during the second and third decades of the 20th century and has attributed this in large part to the increased use of sun helmets (Shattuck and Hilferty 1936, p. 466).

India has continued, after its independence in 1947, to be host to a varied assortment of temperate-zone visitors. Many of these remain at least a year, or even several years. One who reads their reports and reminiscences will be struck by some recurring themes of painful exposure to the Indian heat, remindful of the typical Anglo-Indian reaction. One of the largest self-contained foreign groups to have sojourned in India recently were the several thousand Germans who were employed in technical assistance from about 1957 to 1964 in Central India, at Rourkela, a place where daily maximum temperatures in April - June are normally 110° - 115° F., while night temperatures seldom drop below 85° F. (Sperling 1969, p. 58). Jan Sperling has provided us with a penetrating analysis of the experiences of this temporary enclave group in an alien society and culture. He concluded that

> . . . those Rourkela Germans who insisted on leading precisely the same mode of life to which they had been accustomed at home had little prospect of adapting to the climate. (Sperling 1969, p. 58)[1]

Most of the Germans most of the time enjoyed air-conditioned sleeping quarters. The persistent Indian heat perhaps took second place among them to the fear of "uncanny and virulent" tropical diseases, and

> This fear produced in many of the Rourkela Germans a marked degree of instability, which not only sent them running to the doctor with imaginary or exaggerated symptoms but also gave rise to a fundamentally depressive outlook that had strong repercussions on their general psychological state. (Sperling 1969, p. 64)

---

[1]Poor adaptability was especially seen in regard to diet. Most of the Germans considered that a meal without meat was no meal at all, regardless of whether the temperature was 85° or 110° F., and despite the facts that (1) good quality meat was virtually unobtainable in the first two years, and (2) they were apprised of expert medical opinion that regular consumption of large quantities of meat was not desirable during hot weather (Ibid., p. 67)

Thus the more unstable German workers would become very depressed if one of their number died,[1] or if they heard rumors of an epidemic among Indians around Rourkela, or even from reading newspaper statistics on cholera deaths.

Nevertheless, the powerful effect of the prolonged heat was apparent in medical statistics of the German workers. An observer noted that

> . . . people grow irritable and feel disinclined to work; they tire more easily, lose their appetite, sleep badly, and awake feeling absolutely exhausted. (Ibid., p. 58)

Thus, there were significantly higher rates of reported sickness in the summer and monsoon months, not only for "infection", but also for accidents. As a sampling of the medical record, during the five years 1 July 1958 to 30 June 1963 the Germans at Rourkela suffered a total of 2593 cases of bacillary dystentery, 581 cases of amoebiasis, 211 severe industrial accidents, 46 dog bites (of which 28 were rabid), 13 cases of malaria, and 10 cases of heat-stroke (Ibid., p. 62).

Just as there was a rugged minority among the old Anglo-Indian residents of India who seemed to bask in the torrid climate, and who more or less maintained that "weather was just in the mind, anyway", some recent visitors to India have also found few difficulties in making personal accommodation:

> The heat, from March through early June, requires simply a different daily schedule; up at four thirty or five, like most Indians; retreat and siesta from two to five; and then another period of activity. These are the simplest of adjustments. (Du Bois 1970, p. 234)

---

[1]An interesting footnote to this situation is that when a German died and was buried at Rourkela, his fellows were required to dig the grave. "For religious reasons the Indians were not prepared to undertake such work" (Sperling 1969, p. 66)

However, I suspect that Dr. Du Bois, working in Puri, was fortunate enough not to have been faced with North India at its climatic worst, nor for several consecutive years. Among other writers who have recorded their experiences in trying to cope with the Indian hot season, the chronicle of Jean Lyon[1] is one of the most thorough and fascinating. In seeking to summarize the effect of the April-June period in Delhi, she could only liken her overall response to one of general anaesthesia. It was only when she finally journeyed to a cool hill station that

> Suddently, exactly as through I had emerged from an anaesthesia, my mind began to work. (Lyon 1954, p. 102)

---

[1]Just Half a World Away, pp. 98-103.

LIST OF REFERENCES

Acland, Charles. 1847. A Popular Account of the Manners and Customs of India. London: J. Murray

Agrawala, V. S. 1953. India as Known to Panini. Lucknow: University of Lucknow

Āin i Akbarī (of Abu 'l-Fazl) (trans. Francis Gladwin). 1800. London (2 vol.)

"An Anglo-Indian". 1882. Indian Outfits and Establishments. London: L. U. Gill

Arthashāstra (of Kauṭilya)

Ashby, Lilian Luker. 1937. My India. Boston: Little, Brown and Co.

Ashmore, Harriette. 1841. Narrative of a Three Months' March in India. London: R. Hastings

Atkinson, George F. 1911. Curry and Rice on Forty Plates. London: W. Thacker and Co. (5th ed.)

Bābur Nāma (ed. F. G. Talbot). 1909. London: Arthur L. Humphreys

Barber, Noel. 1965. The Black Hole of Calcutta. Boston: Houghton Mifflin

Basham, A. L. 1963. The Wonder that Was India. New York: Hawthorn Books

Beatson, G. S. 1857. "On coup de soleil, its causes and treatment", The Medical Times and Gazette, n.s. Vol. 15, pp. 624-626

Brown, Hilton. 1948. The Sahibs. London: William Hodge and Co.

The Charaka Samhita. 1949. Jamnagar: Shree Gulabkunverba Ayurvedic Society (6 vols.)

Chopra, Pran Nath. 1963. Some Aspects of Society and Culture during the Mughal Age (1526-1707). Agra: Shiva Lal Agarwala and Co.

Coates, B. H. 1858. "Remarks", Transactions of the College of Physicians of Philadelphia, Vol. 3, pp. 235-236

Cohn, Bernard S. 1962. "The British in Benares: a nineteenth century colonial society", Comparative Studies in Society and History, Vol. 4, pp. 169-199

Collier, Richard. 1964. The Great Indian Mutiny. New York: E. P. Dutton and Co.

Critchley, Macdonald. 1946. "Problems of naval warfare under climatic extremes", The Military Surgeon, Vol. 98, pp. 94-106

Crowden, Guy P. 1949. "A survey of physiological studies of mental and physical work in hot and humid environments", Transactions of the Royal Society of Tropical Medicine and Hygiene, Vol. 42, pp. 325-340

Cust, Robert N. 1881. Pictures of Anglo-Indian Life. London: Trübner and Co.

Dewar, Douglas. 1920. In the Days of the Company. Calcutta and Simla: Thacker, Spink and Co.

_____. 1922. Bygone Days in India. London: John Lane

Du Bois, Cora. 1970. "Studies in an Indian town", pp. 219-236 in Women in the Field (Peggy Golde, ed.). Chicago: Aldine Publishing Co.

Ellis, F. P. 1953. "Tropical fatigue", pp. 21-39 in Tropical Fatigue (W. F. Floyd and A. T. Welford, eds.). London: H. K. Lewis and Co.

Fales, Louis H. 1907. "Tropical neurasthenia and its relationship to tropical acclimation", American Journal of Medical Sciences, Vol. 133, pp. 582-593

Fayrer, Sir Joseph. 1884. "Health in India", pp. 913-958 in The Book of Health (Malcolm Morris, ed.). London: Cassell and Co.

Galbraith, John Kenneth. 1969. Ambassador's Journal. Boston: Houghton Mifflin

Goldman, Ralph F. 1970. Personal communication

Greenberger, Allen J. 1969. The British Image of India. London: Oxford University Press

Havell, E. B. 1915. The Ancient and Medieval Architecture of India: a Study of Indo-Aryan Civilisation. London: John Murray

Huggins, William. 1824. Sketches in India. London

India. Directorate of Economics and Statistics. Ministry of Food and Agriculture. 1956. Indian Crop Calendar. Delhi

India. Ministry of Health. 1948. Report of the Committee on Indigenous Systems of Medicine. Delhi (2 vols.)

Kaviratna, Avinash Chandra (ed.). The Charaka Samhita. Calcutta: the editor

Kendrew, W. G. 1927. The Climates of the Continents. Oxford: The Clarendon Press

Kincaid, Dennis. 1938. British Social Life in India, 1608-1937. London: G. Routledge and Sons

King, E. August (Mrs. Robert Moss King). 1884. The Diary of a Civilian's Wife in India, 1877-1882. London: R. Bentley and Son (2 vols.)

Kipling, Rudyard. 1898. The Phantom Rickshaw and Other Stories. Philadelphia: Altemus

Lawrence, Lady Rosamond Napier. n.d. (1949?) Indian Embers. Oxford: George Ronald

Lind, James. 1788. An Essay on Diseases Incidental to Europeans in Hot Climates. London: J. Murray (4th ed.)

Lyon, Jean. 1954. Just Half a World Away. New York: Thomas Y. Crowell

"M. A. T." 1886. "A visit to a zenana", The Indian Magazine, No. 187, pp. 371-375

Moreland, W. H. 1920. India at the Death of Akbar. London: Macmillan and Co.

Mujeeb, M. 1967. The Indian Muslims. London: George Allen and Unwin

Mukerjee, Radhakamal. 1940. "Ways of dwelling in the communities of India", Asia, Vol. 40, pp. 287-442 passim

Mukherji, A. B. 1968. "Climatological lore in the Yajur Veda", Folklore, Vol. 9, pp. 174-184

Nilsson, Sten Åke. 1967. Europeisk arkitecktur i Indien 1750-1850. Lund: the author

Parkes (Parlby), Mrs. Fanny. 1850. Wanderings of a Pilgrim. London: P. Richardson

Planalp, Jack M. 1958. "Social values and patterns of living", pp. 307-340 in Area Handbook for India. New Haven: Human Relations Area Files (typescript)

Rao, K. Bhaskara. 1967. Rudyard Kipling's India. Norman: University of Oklahoma Press

Renbourn, E. T. 1956. "The spine pad: a discarded item of tropical clothing. An historical and physiological survey", Journal of the Royal Army Medical Corps, Vol. 102, pp. 217-233

_____. 1962a. "Life and death of the solar topi", Journal of Tropical Medicine and Hygiene, Vol. 65, pp. 203-218

_____. 1962b. "Tropical clothing. A physiological appreciation", pp. 91-98 in Biometeorology (S. W. Tromp, ed.). Oxford: Pergamon Press

_____. 1963. "Seasoning fluxes and fevers of acclimatization. An introduction to the history of tropical adaptation", Journal of Tropical Medicine and Hygiene, Vol. 66, pp. 193-203

Roberts, Emma. 1837. Scenes and Characteristics of Hindoostan. London: W. H. Allen and Co.

Saletore, Rajaram N. 1943. Life in the Gupta Age. Bombay: The Popular Book Depot

Shattuck, George C. and Hilferty, Margaret M. 1936. "Distribution of acute heat effects in various parts of the world", New England Journal of Medicine, Vol. 214, pp. 458-468

Silpa Shāstra

Spear, T. G. P. 1932. The Nabobs. London: Oxford University Press

Spencer, J. E. and Thomas, W. L. 1948. "The hill stations and summer resorts of the Orient", The Geographical Review, Vol. 38, pp. 637-651

Sperling, Jan Bodo. 1969. The Human Dimension of Technical Assistance. Ithaca: Cornell University Press

Sreenivasan, P. S. and Ramabhadran, V. K. 1950. "A statistical study of micro-climates", Indian Journal of Meteorology and Geophysics, Vol. 1, pp. 35-44

Steel, Flora Annie and Gardiner, G. 1902. The Complete Indian House-keeper and Cook. London: William Heinemann

Stratton, Arthur. 1955. One Man's India. New York: W. W. Norton and Co

Thoburn, W. C. 1946. "The comfort problem in northern India", Heating, Piping and Air Conditioning, Vol. 18, pp. 120-125

Upadhyaya, Bhagwat S. 1947. India in Kālidāsa. Allahabad: Kitabistan

Willcox, W. H. 1920. "The nature, prevention and treatment of heat hyperpyrexia", British Medical Journal, n.s. Vol. 1, pp. 392-399

Wulsin, Frederick R. 1953. "Hot weather and high achievement", The Florida Anthropologist, Vol. 6, pp. 103-120

Yule, Henry and Burnell, A. C. 1886. Hobson-Jobson. London: J. Murray

ADD:

Trevelyan, George. 1894. Cawnpore. London: Macmillan and Co.

Afnan, Soheil. 1958. Avicenna: His Life and Works. London: George Allen and Unwin, Ltd.

Siddiqi, Muhammad Zubair. 1959. Studies in Arabic and Persian Medical Literature. Calcutta: Calcutta University Press

Leclerc, Lucien. 1960. Histoire de la Medecine Arabe. New York: Burt Franklin (2 vols.) (1st published 1876)

Sanyal, P. K. 1964. A Story of Medicine and Pharmacy in India. Calcutta: Shri Amitava Sanyal

III

ADAPTATIONS TO HEAT IN THE PRESENT: TECHNOLOGY AND BEHAVIOR

A. Technology

1. Houses

A monograph would be required to describe fully the dwellings of the people of North India in all their rural and urban diversity and variety.[1] Indians themselves use the adjectives pakkā and kachchā to distinguish whether walls, floors, etc. are made of stone, baked brick or cement (pakkā), or whether they are of plastered mud or unbaked brick (kachchā).

> The term "pucca" connotes perfection, durability and permanence in the context of housing, and the term "kutcha" means flimsy or impermanent. (Unni and Patel 1964, p. 1)[2]

Modern urban commercial and residential construction is of course all pakkā and despite some possible slight advantage of mud-clay over brick-cement in terms of heat dissipation and thermal comfort, pakkā homes enjoy higher prestige in villages. But they still represent a minute proportion--perhaps two or three percent--of all village homes in North India (Census of India, 1961. Vol. XV. Uttar Pradesh. Part VI. Village Survey Monographs.). Just prior to the 1961 census the average cost of a pakkā house of "moderate size" (probably four or five rooms) was reckoned at Rs. 3000-4000, about three times the cost of a kachchā house (Ibid., Village Survey Monograph No. 7. Village Sumbhadih, p. 11).

---

[1]See Biswas and Behura (1961) for an ethnographic introduction. For Uttar Pradesh, predominant roof- and wall-types are thoroughly mapped in the Census Atlas of U. P. (Census of India, 1961. Vol. XV. Uttar Pradesh. Part IX, pp. 306-313).

[2]Actually, the contrasting adjectives pakkā and kachchā are used in innumerable contexts in India, the former always implying a much higher degree of quality, strength, maturity, etc.

Looking at the two provinces of Uttar Pradesh and Bihar as a whole, the major regional variations in house form appear to be a function of monsoon precipitation. That is, since the monsoon moves westward from the Bay of Bengal across the Gangetic plain, then slowly retreats in the reverse direction, the total monsoon rainfall ranges downward in quantity from east to west. The range in annual precipitation is from about 60 in. on the eastern border of Bihar to 25 in. on the western border of U. P. (e.g., at New Delhi). Thus, while the resulting North Indian house type involves considerations of availability of materials, cost, security, and protection from the thermal environment in about that order of importance, the factor of protection from heavy monsoon rain also plays a determining role. The village houses of western U. P. can afford to have flat roofs made of packed earth on horizontally laid planks, since the threat of prolonged heavy rains is not so great (Ghose 1953, p. 18).[1] In the eastern half of the region, by contrast, only <u>pakkā</u> houses can have flat roofs, for the heavy rain would wash away mud or clay, and the great majority of poor people use either thickly thatched roofs or steeply pitched tile roofs with projecting eaves and verandahs.

> It is interesting that, as one travels from Bengal towards the north-west, straw for thatching first gives place to wheel-made semi-cylindrical tiles in Bihar. Farther west, in eastern Uttar Pradesh, for instance, flat hand-made tiles become increasingly frequent, until in Rajasthan the flat tile alone is employed unless the roof becomes a horizontal one of beaten earth and boards. (Biswas and Behura 1961, p. 9)

A gamut of house architectural features between northern and southern India can also be seen, reflecting differences in the availability of different construction materials, social and cultural patterns, and such factors as the humidity, precipitation and temperature regimes. The student of cultural-environmental relationships will find particularly interesting some observations that have been made of the housing and home life of migrant South Indians from Madras who live in enclaves in

---

[1]The 40-in. isohyet is an approximate dividing line between flat roof and sloping roof predominance, according to the Census of India, 1961 (Vol. XV. Part IX. <u>Census Atlas of U. P.</u>, p. 306)

slum areas in New Delhi. Here the North Indian slum dwellers, habituated to sleeping, cooking and living outdoors in summer, build courtyards and compound walls around their small one-room houses, which are roofed with tin sheet, mats (catāīs), thatch or straw covers (sirkīs). The Madrasis, however, continue to build huts in the Madras style and cook and sleep indoors, even though these are poor adaptations to the hot dry season of Delhi (Subherwal 1961, p. 65). Their huts have palm-leaf roofs and no courtyards.

Typical house plans in the rural districts of eastern U. P. have been well described by R. L. Singh (1957). An upper-class house[1] here includes about five rooms (with a range of from one to 13 or more rooms, and according to tradition always an odd rather than an even number), built of solid mud walls averaging about 3 ft. thick, although they may be 5 ft. thick at the base, becoming thinner as they rise. The walls are erected on foundations from 4 to 6 ft. deep, which preferably include a large proportion of calcareous nodules (kankar) for strength. The wall construction is of mud which is dug from village ponds in the summer when they are dry. Mixed with water, the mud paste can be set in wooden molds to form large 18 x 8 in. bricks. These are sun-dried, and mortared in place by mud. The use of bricks is more universal in western U. P., however, and in eastern U. P. and Bihar the mud walls are often simply built up a layer at a time with mud, to which broken pottery, kankar, wheat straw or the like may be added. An eminent Indian sociologist has held that

> Though broken pottery is often mixed with mud so as to impart some solidity to the walls, the huts of the United Provinces cannot withstand heavy rains. (Mukerjee 1940a, p. 94)

---

[1]This "typical" house is not really average, since an inventory of the 30 or so U. P. village surveys which were conducted in connection with the 1961 Census shows that in 1961 the average house in the average village had only three rooms (of 8 x 10 ft. size), and its cost was estimated at about Rs. 1000. However, it can be safely asserted that the house description which follows here, even if it represents an upper-class rather than a true average model, is nevertheless the ideal to which most villagers aspire, and which an increasing number are achieving.

Indeed, very heavy and prolonged rains always melt away enormous numbers of the humbler, more poorly protected mud-walled homes in North India.[1]

However, when the mud walls are properly constructed and protected by plastering and a sound roof, they are reasonably durable and strong. Dr. R. L. Singh has seen such houses that have survived over a century, although the usual lifetime is probably something like 25 or 30 years (Singh 1957, p. 57). After the mud walls are erected, the outer surface must be carefully and thickly plastered with a combination of mud and bhūsā or wheat straw, mixed in about a 10: 1 ratio. Cow dung may also be included, although it is more often used only for the inner walls, where (in Meerut, at least) it is combined with a special yellow-colored clay (Mukerji 1967, p. 123). The bhūsā and cow dung help to prevent the walls from cracking (Hasan 1961, p. 63). The variety of ways in which northern Nigerians modify their mud and pisé construction, including the use of certain compounds and vegetable juices for waterproofing, as reported by Atkinson (1950, p. 319) seem to be little utilized in North India. It is especially important to protect the windward outside walls during the monsoon by extensive brush scaffolding and to replaster them every year; otherwise, the rains will quickly soften and erode them.

In eastern U. P. ridge-poles made of tree trunks or large branches connect the peaked ends of the wall, while the tile roof is supported by rafters and a closely framed structure of arhar (pigeon-pea) stalks, bamboo, or other woody material.[2] The roof tiles (khaprail) are made

---

[1]In Kipling's India, when expense was less a factor, it was said to be necessary even for pakkā, or fired-brick, walls to be 6 ft. thick if they were to withstand the violent electrical storms and cyclones common in Bihar just before the break of the monsoon (Ashby 1937, p. 101).

[2]A typical western U. P. roof has been described by Wiser. This consists of beams of mango, neem, or shīsham wood laid across the walls, then arhar stalks at right angles, then an inch or so of dried sugar cane leaves (or papyrus bundles if the builder can afford them), followed by a 3-inch layer of mud and a 4-inch layer of hard packed earth (W. Wiser 1933, p. 61). A description for Meerut District, 140 miles northwest of the Wisers' Mainpuri village, is rather similar, except that small rectangular wooden pieces replace arhar, and a 12-inch layer of dry grass is used instead of sugar cane leaves (Mukerji 1967, p. 125).

are made of local clay by the village potters, who shape hollow cylinders with slits on opposite sides to allow their being cleanly broken into two halves after they are sun-dried and baked. Overlapping in vertical rows with flat or shovel-shaped tiles, the resulting roof is colorful, relatively inexpensive, and efficient in keeping out heavy monsoon rains, although wind damage and breakage of tiles require continuous maintenance, a process referred to as anagab in the local Bhojpuri dialect. Some of the same considerations regarding the use of thatch or of tile which were present in the Anglo-India of more than a century ago (see Chapter II) are still relevant today. Singh notes that

> The tiled roofs are not so cool as the thatch roofs but they are more durable. (Singh 1957, p. 58)

Thatch is usually much cheaper than tiles and does not require such heavy scantlings of timber as do the heavy country-made tiles (Deshpande 1935, p. 163).[1] Yet much depends upon local availability of good thatching straw and good clay, and certainly a close scrutiny of the distribution maps of house features (in Biswas and Behura 1961) shows that many factors other than climate must enter into an explanation of their distributions. Especially in some parts of Bengal and eastern Bihar, where timber is most scarce, the poorer families have chosen to use corrugated iron or flattened kerosene tins as roofs.

> The tin and corrugated iron are fire proof and easily portable, and thus the peasant can remove his house and raise it anew at a more suitable site if the erosive action of the river threatens a habitation as it often does. (Mukerjee 1940a, p. 95)

---

[1]Needless to say, a straw roof is immensely superior to a tiled one under the impact of one not altogether infrequent natural hazard in North India: hail. Crops are laid waste from this calamity nearly every year in scattered parts of the country. Some evidence indicates that the hail size limit dictated by theoretical physics (1.5 lb. and 5 in. diameter) may have actually been exceeded in India, and it is at least a fact that men and cattle have been killed by hail (Agarwala 1950, p. 309). Indeed, "Cases are on record when hailstones of five inches or more in diameter have wiped out a whole village, destroying all life, man and animal" (Field 1933-34, p. 790).

In eastern U. P., the larger houses are built in atrium style around an open inner courtyard, the <u>āngan</u>, which has always had a special, a semi-religious, role in the Hindu life-way. Even families whose house does not enclose an <u>āngan</u> attempt to provide some comparable enclosed space adjoining the side or back of the house, using compound walls or temporary thatched structures. The inside courtyard is normally abutted on all sides by a low tile-roofed verandah, which funnels considerable quantities of rain water into the four corners of the <u>āngan</u> during the rains but which provides shade and ventilation. Most houses also have an outside verandah, or <u>osārā</u>.

Rooms are usually 10-12 ft. high at the side walls and several feet higher at the ridge-pole. They may be from 10 to 16 ft. long, but are not more than 8 ft. wide:

> The scarcity and high cost of long and precisely cut rafters and beams is reflected in the narrowness of the rooms. (Singh 1957, p. 53)

The long narrow village rooms are kept dark and windowless, for coolness and for reasons of security from theft and dacoity.[1] Ventilators, about 8 x 12 inches, are uncommon, and where they do exist, are for fashion rather than utility (Khare 1961, p. 129). Actually, they tend to be

---

[1]House burglaries are frequent enough to be greatly feared in North India, and open windows make the work of the <u>cupcāp cōr</u> or "silent thief" much easier. Even without them, these village burglars are expert at quietly digging through the wall in order to reach the box of family jewelry and valuables. Dacoits too are still active; traveling in armed gangs, they may torture the families of wealthy villagers in order to learn the location of buried gold. And in the past year or two the so-called Naxalite revolutionaries in various parts of India have been assassinating prominent village landlords and moneylenders as "enemies of the people", making their attacks mostly at night.

limited to guest rooms, are placed very high, near the roof, and are fitted with iron bars. Even so, they are considered undesirable from the standpoint of security. F. L. Brayne, the indefatigable pioneer in village sanitary improvements in northern India struggled for years with little success to persuade Panjabi peasants to let some light and air into their rooms by ventilators (Mayer 1958, p. 214; Brayne 1944, p. 17). In western U. P., Pittman found that

> . . . every window space in village houses was stuffed with old rags to darken it . . . (Pittman 1951, p.42)

The word ghar in North India means "house", but this term has special connotations. The ghar is the women's house and men of the family do not spend much time in it. The more prosperous and orthodox the family the more this is true. The men of a family have their own place, preferably a separate adjoining building with a verandah, and called the dālān or baiṭhak. The "men's house" is relatively small in size, sufficient to store a few string-beds, some clothing, and other odds and ends frequently used by the men. Here guests and visitors are entertained and, most important, a close watch is kept on the cattle tethered nearby.

The main outside door of the ghar opens into a dyōrhī, an entrance-room which usually contains a grain storage bin, grinding-stones and the like, and this door is always set several feet off a direct line from the inside doorway of the dyōrhī looking into the inner courtyard. This is to ensure the women's privacy and prevent any passerby from seeing into their area. In fact, all house doors are offset in this way, a fact that greatly diminishes the play of cooling breezes through the house (Khare 1961, p. 123). The placing of doorways on the south side of the house is generally prohibited by religious taboo,[1] and inner courtyards which are square or have their long side oriented east-west are also considered inauspicious. (Both prohibitions coincide with the recommendations of modern tropical housing experts based on solar radiation factors). The kitchen area of village houses is usually in the southeast or southwest corner, where the maximum protection from the sun's rays is also provided.

---

[1]It is permissible only if there is a temple or a well directly south of the house.

So far as the furnishing of the house is concerned, most village homes have no furniture beyond charpoys or string-beds, perhaps a chair or two for the use of distinguished visitors, a metal trunk for the storing of valuables and dress clothing, a few footstools, etc. There may be one or more almārīs or shallow shelf-closets built into the wall, equipped with hinged doors. Rugs or carpets are little used in villages. Meals are taken sitting cross-legged on the floor. Mahatma Singh's recent tirade against conditions in northeastern U. P., which he called a "vast developing rural slum", includes the following:

> All that one can find in the dark corners of dingy rooms of an average family dwelling, are a few earthen and wooden pots, a broken cot and mats, a heap of dirty clothes and straw bedding and wooden and stone implements to grind grains. (Singh 1967 p. 102)

The statement is accurate enough as applied to the impoverished majority, but must be balanced against a high regard for household cleanliness and purity, especially in a ritual sense and in relation to the kitchen area, among the more prosperous, socially dominant, land-owning villagers.

In a typical village there are likely to be one or more pakkā houses made of brick covered with cement plaster. The walls are usually two or two and a half bricks in thickness. Sometimes a farmer will have the outside mud walls of his existing kachchā house faced with a single layer of pakkā or fired bricks, both for the sake of appearance and to reduce rainy-season wear. This thin brick facing is known as challī. Pakkā village houses, like those in cities, have flat roofs open to the sky, surrounded for safety and privacy by a parapet.

A very interesting discussion of characteristic house-types in Meerut District of western U. P. is that of Mukerji (1967), who claims, without offering any specific evidence, that among Hindus "different occupational groups" have different types of houses. I am not prepared to offer this generalization with respect to eastern U. P., although no doubt certain minor modifications of the house, especially in its anterior aspect, may characterize such caste-groups as the Lohars (blacksmith-carpenters, who operate forges), the Telis (who often have bullock-turned oil presses inside the house), the grain-parchers, and the petty shopkeepers, for example. Mukerji found that Muslim houses are recognizably distinct from those of Hindus in several ways, all traceable to the exaggerated emphasis placed on purdah, or "the principle of privacy for women". Thus, Muslim outer courtyard walls are quite high, some 8 to 10 ft. They seldom build two-storied houses, which are conducive to easier viewing of their own and others' premises, and when they do, the balcony or roof parapets are augmented by built-up walls of mud bricks or dung cakes. Unlike Hindus, Muslims also provide a small latrine at the corner of the courtyard so the women will not have to leave their domestic sanctum for any reason. On the same grounds, Muslims are quick to buy hand water pumps for their water supply (Mukerji 1967, p. 119). Finally, Muslim houses never have a back door, as do many Hindu homes, and they are especially deficient in windows, to present a facade of strict purdah to the outside world.

It is characteristic of all walls and roofs made of heavy-weight materials with a high heat-storage capacity that they can provide superior protection during the midday thermal peak, since they lag in warming up (Saini 1962, p. 175). At the same time, however, they cool down slowly and thus remain too warm for comfort at night. While whitewashing could reduce maximum wall and roof external surface temperatures by 40° F. or more (Bhattacharjee 1965, p. 14),[1] most people living in <u>pakkā</u> houses do not have this done very often. Measurements by Subrahmanyam and Majumdar of temperatures inside Indian houses with various kinds of wall and roof materials show that the roof material has a far more noticeable effect on indoor temperature than the wall material (Subrahmanyam and Majumdar 1952). They found the coolest house to be one with 10-inch brick walls and a jack arch roof with lime concrete terracing.

The ambivalence of the typical North Indian villager's attitude toward house construction has been well indicated by Khare who, like other anthropologists who have studied the village ideology of health in India, was greatly impressed by the peasant "soil-and-health mystique". One of the ancient rishis is said to have declared that

---

[1]Whitewashing of the external surface of a 9-inch sandcrete and plaster walled bungalow reduced the temperature of the inner surface of the wall by about 4 F.$^{\circ}$ in tests cited by Crowden. But whitewashing of corrugated iron sheets reduces the temperature under them by about 25 F.$^{\circ}$ at 2:45 p.m. under full sunlight (Crowden 1947, p. 363).

"It is impossible for one to attain salvation who lives in a town covered with dust." (Mukerjee 1940b, p. 290)

Khare's village informants (near Lucknow) saw themselves as "sons of the soil", who "grow, produce, live and die surrounded by Mother Earth". Village air, water and earth--including dust and dirt[1]--were described by these men as "100 times cleaner than those in the cities" (Khare 1961, p. 98). Thus, villagers believe their mud-walled houses are "more suited to the village" and are healthier than brick ones, partly because they maintain a symbolic oneness with Mother Earth. In addition, mud walls are felt to be more cool and moist, and villagers say that the firing of bricks makes them lose their coolness (Ibid., p. 126). Villagers do not object to dampness, especially in the dry summer. Finally, mud and thatch houses are cheap and easy to build, and do not offer so much invitation to robbery.

Despite all this, in Khare's village and throughout North India more and more pakkā houses are being built, partly because improved methods of construction make them superior to pakkā houses of earlier years, but mainly for reasons of prestige. They are being introduced reluctantly, according to Khare, yet at the same time they represent the ideal or ambition of most villagers.

At the other extreme, relatively impermanent homes made entirely of thatch screens may still be found in North Indian villages, especially in Bihar and among certain aboriginal and semi-aboriginal tribes and castes, such as the Musahars in eastern U. P. These houses are vulnerable to fire and afford no protection against burglary except their

---

[1]The Hindi word for soil is miṭṭī or maṭṭī (earth, clay), whereas dhūl means "dust, dirt". However, Khare specifies that dhūl is used in two senses: (1) "clean dirt", or dust that is not separated from the soil; and (2) "unclean dirt", which has been separated from the surface and, especially inside the house, is regarded as refuse (Khare 1961, p. 127). Earth as such can never be aught but pure to the villager. It must be used, for example, for washing the hands before going to worship at the temple, because soap is ritually impure (Ibid., p. 140).

self-evidence of penury. While their insulative value against winter cold and winds, daytime heat and heavy monsoon rains is more or less inferior to the mud-walled house, they are very inexpensive and can be quickly erected. In fact, many villagers use some such thatched sheds as temporary men's sitting rooms or as shelters for boiling down sugar cane juice, etc. But only the poorest families make their homes entirely of thatch.

When maximum daytime temperatures reach the 110° to 115° F. level, as they often do during May and June, villagers cannot find any really cool place in which to rest. However, they must seek some shade, for by three hours after sunrise the globe temperature in the sun has almost reached its maximum excess of 20 F.° above the dry bulb shade temperature in the same location (Ladell 1955, p. 15). Even the dark interior rooms of the house are not more than 10 or 15 degrees cooler than the outside shade temperature. However, Deshpande claims that

> It is the common experience that to those accustomed to a temperature of 115° F., 100° F. gives as much comfort as 82° F. temperature gives to people living in temperate climates. (Deshpande 1939, p. 118)

A small degree of amelioration in summer heat may also be provided in some cases as a result of the evaporation of water from small village buffalo-tanks and ponds. However, most of these are dry by June. More significant is the effect of the large spreading trees, especially neem, mango, pipal and tamarind. Large trees of these kinds can result in an increase in the moisture content of the air below them and a decrease in temperature of up to 10 F.° (Bhattacharjee 1965, p. 53).[1]

Urban housing patterns in North India are much more varied than rural housing. There are families who live in modern air-conditioned apartments and houses in New Delhi and Lucknow. At the opposite extreme are the thousands of men--migrants from the countryside, beggars and vagrants--who have no home in the city except some sleeping space on the

[1]But trees are not usually allowed to overhang the inner courtyard of the house, however beneficial they might be in providing some coolness. The reason is that bird droppings might pollute the kitchen area.

ground or pavement, where a man counts himself fortunate to enjoy a mat beneath him and on rainy nights some shelter overhead. The rickshawallahs or pedicab drivers often sleep curled in their vehicle (Gould 1965, p. 43). The jhabawallahs, a step below them, sleep on the ground covered by their one possession, the flat basket (jhābā) by means of which they earn a few cents a day as head-porters of grains and vegetables. Between these extremes are the urban multitudes, numbering more than twenty million people in the cities of Delhi, U. P., and Bihar. They include an urban professional and official class most of whom live in relatively new colonies, in apartment housing or in older spacious bungalows. They include mercantile castes many of whom still reside in the jumbled hodgepodge of the old bazaar section, with its narrow streets and antiquated 3 or 4-storied buildings, some of which may hold apartments of surprising charm and comfort but more of which are bare, dank and crumbling.

But most of all the cities are composed of low-salaried workers, dwelling in slums, near-slums or at best one or two-room pakkā housing units provided by the government or by their employers. Outlying sections of cities are in fact much like villages in their house-types. An urban housing survey in Kanpur in 1958 showed that about 82% of workers' families occupy one-room and 16% occupy two-room tenements, and that two-thirds of families pay less than Rs. 20 per month as rent. Forty-seven percent of the one-room tenements have a verandah only, 6% a courtyard only, 17% both, and 30% neither. Five percent of the dwellings have electric light, while 95% use kerosene lamps. The average dimension of one-tenement rooms is 87.5 square feet and 995 cubic feet and the average number of persons per room is four. About 82% of slum walls in Kanpur are pakkā, while 18% are kachchā. From 30% to 50% of roofs are pakkā, 26% to 40% tile, 15% to 20% wooden, 6% kachchā[1] and 3% of metal sheet. The dwellings usually have no windows or skylights, and in fact are dark dingy hovels (Singh and Singh 1960, pp. 47-70). Most depressing is the fact that these statistics represent a deterioration rather than an improvement, as compared to ten years previously, and that current data would also probably show little change since 1958.

---

[1]That is, earthen or thatch. Some of the percentages shown here are imprecise by reason of differences between the two sources used (Singh and Singh 1960; Sharma 1964).

The 1961 Census of India collected many statistics on the proportions of flat roofs versus sloping roofs in major Indian cities. With respect to U. P.,

> The most common roofs in Kanpur and Varanasi are made of concrete-and-stone slabs, in Agra and Lucknow of brick-and-lime laid on beams, and in Allahabad of tiles. (Census of India, 1961. Vol. XV. Uttar Pradesh. Part X. Special Report on Kanpur City, p. 34)

But variations between cities are not entirely correlated with rainfall. As the Census report further expounds,

> Tiles are so common in Allahabad that a particular type which is much prized is known as Allahabad tile. Varanasi, in spite of being an eastern city with a copious rainfall, has a preponderance of flat roofs of concrete and stone on account of its massively built pattern. (Ibid., p. 34)

Obviously, for the great majority of urban residents in northern India housing patterns are determined mostly by economic limitations and the availability of materials rather than by thermal environmental considerations. Nevertheless, some adaptations may be noted, such as screens and overhangs, verandahs, courtyards and open roofs.[1] One practice that is sometimes seen in both villages and cities is the growing of heavy-foliaged climbing gourd or squash plants over the roofs of low houses and huts. This vegetation provides a degree of insulation from the sun's rays, although it is planted principally for its crop value.

The middle and upper-class urban houses present an amalgam of indigenous and Western concepts and features. It has been frequently observed (Lee 1963; Thoburn 1946, 1954) that there is a widespread and

---

[1]According to one expert, the old-fashioned verandahs and chajjās (overhanging or projecting eaves) on Indian buildings are superior to the famous "sunbreakers" or large, perforated screens so widely used by Le Corbusier in the building of Chandigarh. These have proved to be fine collectors of dust, dirt, and pigeon's nests (Fabri 1963, p. 56).

deep-seated belief in India that high ceilings are essential to summer coolness. In fact, according to Thoburn, municipal regulations in the past have commonly specified the minimum heights of residential rooms, e.g., in Lahore (now in Pakistan) 12 ft. for the ground floor and 10 ft. upstairs (Thoburn 1946, p. 122).[1] Ceiling heights in all the middle and upper-class Indian houses or bungalows dating from the Anglo-Indian era range from 12 to 22 ft. Lee has presented evidence that lowering the ceiling height from 12 to 8 ft. results in very little increase in the radiant heat load. Thoburn also determined that the film of hot air inside rooms lies essentially within three inches of the masonry surface and that it is no more humid than the air below (Thoburn 1954, pp. 575-6). However, this finding may be valid only if there is sufficient ventilation by windows, and

> Houses abound in northern India which have in fact no windows at all except for the high-placed ventilators called roshandans and these ventilators are often much too small to be effective. (Ibid., p. 531)

Lee indicates that the conventional high ceiling in Indian houses creates a trap for hot air, so that any improvement from reduced radiation is offset by the increase in conduction (Lee 1963, p. 40). It appears that the new houses and apartments being built in North India today have rather lower ceilings than in the past, but quantitative information is lacking.

Tropical housing experts in India and elsewhere have carried out extensive studies of architectural design in relation to climatic conditions.[2] By and large these studies fall outside the scope of the present report since they refer to proposed or ideal rather than to existing solutions. Particular attention has been focused in India on low-cost housing designs, and in connection with the International Exhibition on Low Cost Housing in New Delhi in 1954 an assessment was

---

[1] Unfortunately, I have no information on the current existence or extent of such building regulations in North India.

[2] See, for example, Olgyay's detailed and formidable "bioclimatic approach to architectural regionalism" (Olgyay 1963).

made of the thermal environments inside the various models of inexpensive houses that were exhibited. Two specific conclusions drawn from these studies were:

(1) The roof is the most important part of the house so far as thermal comfort is concerned, and ceiling temperatures can be reduced considerably by whitewashing the roof; and

(2) The ceiling and ceiling fan should be at least 7 ft. 6 in. in height, but additional height beyond 9 ft. does not materially contribute to thermal comfort (India. Ministry of Works, Housing and Supply, 1957, pp. 110-114).

Of course, scientific knowledge of housing and environmental biophysics will presumably make itself increasingly felt in Indian architecture in the future, as recent statements indicate (see Prasad 1968). This knowledge includes better protection from the sun and improvement in air circulation. Examples of the former are: orientation of long axis of buildings 20° north of east; use of parasol roofs, lime concrete slabbing or double roofs; use of high heat storage materials and light-colored surfaces; maximum utilization of sun breaks, screens and various kinds of external shade; and so on. Examples of the latter are: use of ventilators, registers, movable partitions and wind scoops; morphology to catch east-west winds; and especially the planning of urban construction to avoid creating pockets of hot still air by the blanketing of breeze (Trompf 1965, p. 65). The thermal biophysics of tropical housing have been well explicated by D. H. K. Lee (1958, 1963).

The fact remains, however, that modifications in construction which reduce solar heat in summer tend to be undesirable for the winter season and--even more important--the west wind that is so useful in reducing the humid heat stress of August and September, in May and June is the l̄u or fierce furnace-wind, often carrying suffocating dust.

First-time Western visitors are often surprised to find the rooms and homes of many Indian families of means to be so spacious and yet so bare of carpets, furniture, curtains, etc. In part this is a matter of habit and custom, but in part it is a realistic adaptation to a climate which confronts houses and their furnishings with enormous quanta of dust, heat, mold and mildew. In this situation the Indian has found it well to keep room interiors unencumbered while at the same time capable of being closely shuttered against violent dust and rain storms.[1] Most important of all, in the better urban houses and apartments, is the bare cement floor, which can so easily be washed daily and which provides simultaneous cleanliness and coolness.

2. Clothing

The first line of technological defense against heat and cold is clothing, a layer of insulation which augments the skin. Clothing interacts for the better or worse comfort and health of the human body in relation to several critical factors: ambient temperature, solar radiation, air movement, atmospheric humidity, body temperature, etc. (see Appendix C). Evaporation of sweat is the body's principal method of achieving sufficient cooling to maintain body temperature at a safe level. All other things being equal, therefore, the best clothing in warm climates is that clothing (theoretically sometimes the total absence of clothing) which allows or promotes the most efficient evaporation of sweat. All other things are not equal, however, since solar radiation imposes a significant additional heat load on uncovered skin,[2] since wind and surrounding objects at ambient temperatures above body temperature will add heat to the thermal equation through convection, since cultural factors may prohibit and other environmental hazards discourage nudity, etc.

In terms of our modern knowledge of the biophysics of clothing, the basic North Indian dress is relatively well adapted to the hot-dry environment. In the case of both men and women the standard garment is a length of soft cotton cloth some 3 to 4 ft. wide (depending on the

---

[1]The ferocity of these storms in North India explains why home-owners and house architects dare not concentrate exclusively on thermal protection. Dust storms in the hot season may last for hours, reduce midday visibility to a few feet, and leave every inch of even the most tightly-closed rooms covered with a layer of fine grit. For a most graphic description of the notorious North Indian ā̃ndhī or dust storm see Thornhill (1899, pp. 35ff.).

[2]An accurate estimate of the total heat imposed per unit surface area by direct sunlight must take into account such variables as solar zenith angle, terrestrial elevation, and water vapor and dust content of the air. Roller and Goldman (1967) have presented a systematic method for this calculation. But there remain the complex problems of skin reflectivity and absorptivity, which vary on the basis of pigmentation.

individual's leg length), about 4 yd. long for men and 5 to 6 yd. long for women. Most North Indian women wear their garment, the sāṛī,[1] as a wrapped-around skirt that reaches almost to the ground, generally (among village and working-class urban women) without a petticoat or other undergarment, and with the loose end thrown over the shoulders and head in such a way that the face can be easily shrouded.

Village men wear their dhotī with no undergarment except sometimes a loin-cloth (laṅgōṭī). A man pleats up his dhotī from both ends, places himself in front of the center of it while holding an end in each hand, secures the two pleated ends at his stomach by twisting them securely like a belt, then pulls the bottom of the left free end backwards between his legs and tucks it into his waist-back. The bottom of the right free end may then be tucked in the front. The dhotī may be worn long enough to touch the ground or well above the knees, depending on the size of the garment, how it is tied and adjusted, the status or preference of the wearer, and the occasion--whether for plowing a field or for dress-up. The net result, at any rate, is that the only area of constriction is around his waist, and most of the lower part of the body is either bare or is covered by a single loose flowing layer of cloth. As Leix notes,

> The waving ends of the garments have a certain fanning effect, which is very pleasant in view of the prevailing heat. (Leix 1940, p. 1291)

Upper-class women often wear silk (and nowadays synthetic fabric) sāṛīs, and in fact it is only in poor families that the wife does not have one silk garment for special occasions. People believe and claim that silk "feels cooler" than any other material--so much so, in fact, that some people avoid wearing silk in the winter by reason of alleged cold discomfort. Shirts or shirt-like tunics for either sex may also be made of silk. But the high cost of this material greatly limits its

---

[1]Villagers generally apply the word "dhotī" to both the male and the female garment, at least the everyday cotton variety.

availability for most people.[1]

Although infants in village India are always well covered to protect them against heat and cold (Hasan 1961, p. 111), it is a matter of observation that small children are naked or nearly so throughout much of the year. Children of primary-school age may wear shorts (boys and girls), frocks (girls), or a form of pyjamas (boys). Mere loin cloths, limited to very poor village untouchables, are no longer often seen. Schoolgirls, especially in the cities, over the age of ten or twelve now frequently wear the outfit derived from Panjabi female dress: a long (almost knee-length) colorful kamīz ("shirt"), worn over white cotton trousers (salvār) which are cut extremely large at the top, but drawn tight at the waist with a drawstring and fitting rather closely at the ankles. Among adult women in U. P. and Bihar, only those of Panjabi origin wear the salvār-kamīz, and many of these have come to prefer the sāṛī to their original dress (for conformity, and for convenience in purchase and care).

Men are frequently bare from the waist up,[2] but among the women a blouse is generally worn in public except by older village women, who are covered by the sāṛī alone. There is no special headwear for women; village cultural etiquette requires them to cover the head with the sāṛī, and this of course also protects them from direct sunlight. In the case of men a pagaṛī or turban wound from a length of fine muslin cloth is the traditional upper-class fashion, and in one or another form it has been a hallmark of North Indian dress since Vedic times (Macdonell and Keith 1912, Vol. I, p. 104). The turban is still

---

[1]The All India Consumer Expenditure Survey revealed that (in 1965) the average monthly per capita clothing expenditure for all classes was Rs. 1.66 per month, ranging from Rs. 3.36 for the "professional and technical" group to Rs. 1.45 for "farmers". Most of this expenditure was for clothing of cotton material. The figures for woolen clothing were: all classes Rs. 0.11, "professional" Rs. 0.75 and "farmers" Rs. 0.05, and those for silk, rayon and nylon were Rs. 0.08, Rs. 0.60 and Rs. 0.04 for the three groups (National Council of Applied Economic Research 1966, pp. 136-141).

[2]Ford Foundation study teams found that "There were places where all castes except Brahmans were especially forbidden to cover that part of the body above the waist" (Taylor et al. 1965, p. 49). But these places were probably in South India.

an essential article of apparel among Sikhs everywhere, and it is also a common feature of men's dress at the western extremes of North India in Rajasthan and Maharashtra. However, in an interesting parallel with the simplification of head covering among the British in India, the turban has become almost obsolete over the greater reaches of the Gangetic plain. To a large extent it was replaced during the Nationalist movement by the Gandhi cap, a simple white cotton "overseas cap" (Rama Rau 1944, p. 39). The expense and difficulty of maintaining the old-fashioned turban was another cause for its decline (and of course its military value had largely vanished when guns replaced swords).

However, a kind of rough and ready substitute for the turban is in fact very widely used by village men of upper and lower caste alike throughout U. P. and Bihar. This is a gamcha, a colored (usually red or green checked) scarf of porous cotton cloth about 24 x 48 in. in size. It serves a multitude of purposes--coin purse, shopping bag, lunch box, strainer of liquids, head pad for carrying loads, temporary loin cloth while bathing at the well, a belt while working, climbing or fighting, etc.--but its primary function may well be that of a handy wrapping to protect the head from either cold in winter or direct sun in summer.

Certainly one will see few men, other than some of the rebellious younger or student generation, who walk abroad in hot sunlight with their heads bare, although they are also generally averse to hats of the sola topi or other broad brim style:

> Some think that the sun is not only dangerous for the head but may also help hair to grow gray. Others say that wearing a topi all the time may make your hair fall out. (Cline 1943, p. 109)

In any event, North Indians are often horrified that Western visitors do not apply hair oil, with its assumed protective and beautifying functions, in the extensive manner common to themselves.

Village upper-class men wear a traditional type of leather slipper, often locally hand-made, and some men and women wear sandals. Males make much use of wooden clogs, especially around the house and in the rainy season. Socks are not a usual village item of clothing, even in winter. It is as true today as it was in the golden age of two millenia ago that

> In most parts of India footwear was primarily used to protect the feet against the scorching earth of the Indian summer . . . (Basham 1963, p. 213)

Yet, today in North India my estimate is that the percentage of rural men who wear any kind of footgear, at least on mild days, is in the 20-30% range, while among urban men it is perhaps 60-70% (Planalp 1966).[1] The figures are lower for women, much lower for children. However thickly calloused the villager's sole has become, to walk very far on pakkā roadways on a cloudless summer day can be painful.

The foregoing description of clothing has been a modal one, conforming primarily to villages in eastern U. P. Many local and sub-cultural variations exist.[2] In western U. P., for example, the women of some castes wear an ankle-length full skirt in vivid color rather than a sārī, and certain groups of village Muslim women wear a rather heavy type of black salvār-like trousers. Throughout North India, Muslim men are more likely to wear either pyjamas or a lungī (a patterned cotton wrap-around skirt) than a dhotī. (Pyjamas heavily predominate in the western part of the region, but share popularity with the lungī in the east). Many younger Hindu men also now wear the pyjama, a loose garment secured at the waist by a drawstring, instead of the dhotī. The pyjama is rarely worn without an accompanying long-sleeved and loose-fitting kurtā or shirt of pull-over or closed-front type.

A large proportion of Muslim women in North India are still confined to the burka (burkā or burqā) when they leave the house. The burkā is a tent-like dress which covers the body completely from head to toes,

---

[1]The All India Consumer Expenditure Survey arrived at monthly per capita footwear expenditures of Rs. 0.13 for the "farmer" and Rs. 0.47 for the "professional" categories (National Council of Applied Economic Research 1966, p. 147).

[2]See Ghurye 1951, Das Gupta 1961, and Rajalakshmi 1961 for studies of the regional variations in Indian dress.

leaving only small netted openings for the eyes. The burka may be made of cotton or of silk, and there are many

> . . . nuances of cut, of the quality of the material, of color, and even of the way it is worn. (Vreede-de Steurs 1968, p. 59)

Muslim women of the "respectable", but lower and lower-middle classes, wear a white cotton burka, which is heavy and suffocating, letting no breath of fresh air pass. Since a burka cost, according to Vreede-de Steurs, at least Rs. 20 in 1960, sometimes the women of a family take turns wearing a single common one. Although the silk burka worn especially by upper class women is usually black in color, it is actually relatively comfortable in hot weather. It consists of two pieces, a sort of long sleeveless coat, and a cape veil covering the head and shoulders and reaching to the waist. Along the hem of the veil is attached a very light, transparent smaller veil designed to cover the face and breast, but in such a way that it can easily be thrown back.

Both the burkā and the heavy and close-fitting black trousers just mentioned, which I have observed being worn by some village Muslim women in northwest India, would appear to be a good example of the power of cultural tradition and conformity to override personal comfort in relation to climate. Burka-wearing women generally admit to much heat discomfort, especially in the humid season. However, they do not wear the burka inside the house, away from public view.

European dress has had no influence on the village sārī,[1] and among women in North India the wearing of a dress or frock is virtually a symbol of identification with the modern Anglo-Indian (Eurasian) community. Among men, however, trousers are widely accepted among the official, professional and student groups, and are a part of the costume of all who wear uniforms, from soldiers to caprāsīs (the ubiquitous office peons and messengers). Tradition-minded villagers have been slow to accept Western-style trousers and it is frequently observed that an educated man, accustomed to wearing trousers in his job in the city, will change to a dhotī in the train before arriving on a visit to his home village, in order not to become the object of critical comment.

---

[1]But "mini-saris" have made a tentative appearance in certain chic circles in Bombay and New Delhi!

Differences in clothing behavior should be expected between the hot-dry and the hot-wet seasons, in view of the crucial role of sweat evaporation in body cooling. In fact, my informants in Varanasi generally agreed with my own observations of clothing behavior in U. P. when they stated that garments which cover the whole body (arms and legs) loosely are more commonly worn for outdoor activities in the hot-dry season, while shorts or short-length dhotis with minimal covering of the torso are relatively more typical of the hot-wet season (in the case of men, especially). Unlike in May, field laborers in August and September usually work without shirts, although their heads are protected from the sun by a wrapped towel or a gamcha.[1]

This same difference in hot-dry and hot-humid season clothing is obvious when one contrasts regional clothing--for example, the dress (especially of men) of arid, semi-desert Rajasthan to the west of the area of this study, and that of humid, sultry Bengal to the east. An eminent Indian jurist has given a highly personalized but persuasive illustration:

> Living for a long time in Rajputana, where they dress so as to cover the whole body, I began to hate the costumes of Bengal and Madras Presidency. On a visit to Calcutta in the rainy season I called on the late Justice Sir Gurndas Banerjee and the late Justice Sir Asutosh Mukerjee. Both of them had only dhotis on when I saw them. I wondered

---

[1]The biophysical basis for this clothing behavior was aptly documented by Molnar and his colleagues, who calculated on the basis of comparative "desert" and "tropical" environmental studies that the heat gain of a nude man sitting in the desert sun is reduced from 380 kcal/hr to 210 kcal/hr by clothing. However, in the humid tropical environment, the heat gain of a nude man in the sun is only increased over that of a clothed man from 85 kcal/hr to 110 kcal/hr (Molnar et al. 1946, p. 417). These increments may be compared to the metabolic heat gains which accrue from the following levels of activity: walking at 5 mph (525 kcal/hr); walking at 4 mph (285 kcal/hr); walking at 2 mph (158 kcal/hr); and seated at rest (83 kcal/hr) (Lee 1964, p. 35). (These figures are based on the assumed average American man, weighing 75 kg. and with a body surface area of 1.7 square meters.)

> how the two ornaments of the Calcutta University, representing its highest culture, could present the spectacle of semi-naked barbarians. But I was soon disillusioned. The room in which I was staying had no fan, and sticky heat compelled me to fling away the last shred of cloth on my body. (Shankar 1924, p. 636n)

The fabric that is the cheapest and most commonly used by villagers in North India is called hendlūm (from English "handloom") or "mill khaddar". It is handspun but mill-woven, in contrast to actual khaddar, which is handspun and hand-woven. It is often referred to as moṭā (thick) cloth, since it is thicker than "mill cloth" (machine-spun as well as mill-woven). It sells at about Rs. 1.50 per meter,[1] half the price of khaddar, while mill cloth costs about Rs. 1.75 per meter. While mill cloth is desirable from the standpoint of appearance, durability, etc., it is considered less cool and comfortable than hendlūm, due to the closer weave. The lightest weight fabric is malmal, a very thin soft muslin that is often used to make the kurtā or long-sleeved neckless shirt that is worn with dhotī or pyjamas. It costs Rs. 3.50 per meter, and thus tends to be restricted to upper-class hot weather wear. Most of my informants agreed that for the hot sultry season malmal is the coolest fabric, a subjective view that accords with the technical findings of Perti and Lal (1955, p. 947). As Napier states,

> Clothes catch the radiated heat and interfere with air movement around the body, holding warm damp air in close contact with it. The thinner and more open-woven the clothes the less will be the interference. (Napier 1943, p. 8)

So far as scientific evaluation is concerned, however, it should be noted that Renbourn has recently challenged the idea that nudity is always the best garb for damp heat. He grants that this may be true in climatic chambers or while working, but speculates that it may be that

---

[1]The prices quoted are approximate, as of October 1966, according to my informants in Varanasi. At this time daily wage rates for unskilled laborers in U. P. were about Rs. 1.75 to Rs. 2.00 (U. P. Economic and Statistical Bulletin). Based on the clothing consumption data cited above, the average man bought only about 10 meters of cotton cloth annually.

clothing absorbs liquid that would otherwise drip off and so gives a somewhat larger functional "skin" area for heat loss, while its ventilating properties may also reinforce convective and evaporative cooling (Renbourn 1962b, p. 96).

For the hot dry season, most of my informants asserted strongly that either khaddar or thick moṭā cloth is superior for comfort. They explained that "moṭā cloth protects from heat, from lū", or that "moṭā cloth creates perspiration and so makes one feel cool when the air moves". Here we are clearly reminded of the old Anglo-Indian attitude toward wearing flannel in order to help the skin "to breathe". Renbourn offers a modern explanation for the virtues of cotton, and especially of wool, in tropical clothing, noting that they

> . . . take up a considerable quantity of insensible and liquid perspiration into the fibre substance and, hence, do not readily feel damp to the skin . . . (Renbourn 1962b, p. 95)

The handspun material is more open and porous; however, the more prosperous and sedentary among my informants tended to favor malmal for comfort in both dry and humid heat. Renbourn notes that thin tight weaves are about as good as thicker open materials for shirts, etc., and have the additional advantage of keeping out hot winds, fine sand, and biting insects (Ibid., p. 96).[1]

During the hottest days of summer when the lū wind is blowing, under a blazing sun at temperatures of over 110° F., many men believe that a heavy woolen garment provides the greatest degree of protection against heatstroke or other heat injury. One Indian scientist recalled having seen cartmen--the drivers of bullock-carts, who must often travel during the hot days--wearing woolen overcoats in the summer. This seems a little unlikely, unless such coats came from British army stocks or were

[1]Here I must take spirited exception to the statement that thin muslin serves better than a thicker cloth to ward off biting insects--at least, so far as the individuals of the Cimex species are concerned. I quickly learned, whenever wearing a dhotī of malmal in India, to place some thicker material between myself and charpoys, wicker chairs, etc., for the Indian bedbugs which flourish in these sites find no difficulty at all in penetrating the thin muslin cloth.

actually blankets instead of coats. But it is reminiscent of the dress adopted by many village men at the present time when they find it necessary to travel at midday (see Figure 3). This consists of a coarsely woven, dark blanket of the kind made by Garariyas, the caste of sheep-herders. The Garariyas themselves are famous for the use of these blankets, which serve them against cold, rain, heat and l<u>ū</u> alike. As recollected by one writer,

> . . . I could see a group of villagers sitting and smoking, with their black home-spun blankets thrown over their heads and shoulders to protect them from the sun. Those blankets were their constant attire; they were always there, whether it was hot or cold. (Ahmed 1965, p.65)

The blanket--or even more commonly, a cotton cadar or sheet--worn as illustrated in North India appears to approximate the heavy burnoose of the Arab in its function of insulating against the hot dry wind which can quickly upset the body's heat and water balance through convectional heating. It is interesting to note that the wearing of woolen shirts in hot desert heat has also been described in U. S. Army camps in Texas and the Southwest, since in hotdry conditions

> . . . wool will ward off the rays of the sun that would otherwise penetrate cotton. (Borden, Waddill and Grier 1945, p. 1205)

3. Cooling Devices

Many of the old Anglo-Indian devices to reduce the effects of environmental heat, such as evaporative cooling by khaskhas tatties and the swinging punkah, are still employed to some extent by North Indians, at least in homes and offices which can afford servants but do not have or cannot afford air conditioning or electric power. The thermantidote, however, seems to have quite disappeared from the scene.

The most ubiquitous personal item, amounting virtually to a clothing accessory, for protection from solar radiation is the umbrella (chātā) or parasol.[1] The umbrella-making craft is an ancient one in India, dating

[1]An impromptu version made use of by very poor people is a single fan palm leaf held on the head (Blatter 1926, p. 191).

back at least 2000 years. During the Sutra period,

> An umbrella and a staff were considered to be necessary paraphernalia of a gentleman. (Gopal 1959, p. 161)

Both folding and non-folding types of umbrellas were made in the Gupta period, all of wood. However, there were strict codes requiring the umbrellas of common people to be only half the length of those used by princes, while the umbrellas of the latter in turn could be only three-fourths the length of that of the king. Interestingly enough, women apparently used umbrellas during this Buddhist period to a greater extent than they do today (Mazumdar 1960, pp. 195-6).

In Kipling's India, the non-folding palm umbrellas (palm leaves spread over bamboo) which had largely prevailed among what were described as the "better classes" of Indians were well on the way to displacement by factory-made ones of cloth. Balfour says that (about 1880) some two or three million were imported annually, two-thirds from England, to sell at an average price of 12 annas (Balfour 1885, Vol. I, p. 972).[1] However, according to one source, both Indians and British residents in India favored the covering of the umbrella with white calico or other sheeting, "to make it impervious to the sun's rays" (Fayrer 1884, p. 943).

In fact, the use of umbrellas throughout Indian history has been associated with royalty or with social privilege. Mrs. Das noted that when village men encountered her husband on the road they would respectfully close their umbrellas and

> . . . if any one of these men thirty years ago had even dared to carry an umbrella, open or closed, we would have ordered our servants to go, take it from him and break it at our feet! (Das 1930, p. 223)

Up until recently, complaints were frequently made of the beating or persecution of untouchable men and boys who dared to carry an umbrella even on the hottest days (Saint Nihal Singh 1913, p. 378; Mohinder Singh 1947, p. 143).

---

[1]This sum, equal to three-fourths of a rupee, in 1880 had a buying power perhaps twelve times as great as it does today.

Figure 3. An Example of Hot-dry Season Garb in Rural North India.

This photograph is of a Madhopur (eastern U. P.) village man of lower caste, dressed for walking through the fields on a hot summer day when the lū wind is blowing. A cotton cloth is wrapped on the head as a turban, and a bamboo stave is always carried for self-defense. He informed the author that the woolen blanket "gives a feeling of coolness because it causes perspiration".

The umbrellas carried by men in North India today are dual-purpose, for both rain and sun. They are black in color, and priced at as little as Rs. 5.00, they are well within the range of perhaps the upper 20 or 30 percent of the population. Due to the dryness and midday <u>lū</u> they are of course less useful in the summer than in the sultry monsoon season.

There appear to be some inexplicable regional differences in umbrella use in North India. I observed umbrella-carrying in Patna, Bihar late in September 1966, when daily maximum temperatures ranged between 92° and 95° F., with no clouds (but with high humidity and daily unrealized hope of rainfall). A random counting of hundreds of pedestrians walking to and from work in the city--a large proportion being official and clerical staff in government bureaus--revealed that about 30-40% of them carried umbrellas raised against the sun. This was true as early as 8:30 a.m. and as late as 4:30 p.m. Police constables who direct traffic in Patna wear a sturdy leather belt fitted with an umbrella holder, enabling them to keep both hands free while enjoying the umbrella's shade. In Allahabad, Lucknow and New Delhi, however, I observed only a small percentage--less than 10%--of umbrella-carriers at nearly the same time of the year and among a similar population. No explanation for this difference has been forthcoming from informants beyond hazarding the guess that the Bengalis and Biharis in the eastern part of North India "have more delicate constitutions and cannot stand the sun as well as the people in northwestern India". Police constables in eastern U. P. cities do not use the belt umbrella-holder; however, the safety islands at most traffic intersections there are permanently shaded by large umbrella-like round concrete overhead shelters against sun and rain. The much greater observed use of the umbrella in Patna as compared with Allahabad or Lucknow may be related to simple differences in rainfall.

Another umbrella-like device, but not a readily portable one, can be seen especially along the banks of Indian rivers at religiously important bathing sites, where it is used by those Brahman priests known as Pandas who sit all day long providing essential religious services for bathers and pilgrims. These umbrellas, known as <u>chatarīs</u>, are up to ten feet in diameter and are made of closely-woven bamboo by families of a certain caste which specializes in the bamboo-working craft.[1]

---

[1] In most places, they belong to the same caste which makes <u>tattīs</u> and <u>ciks</u>. In the Varanasi region they are Dharikars, apparently originally a section of the lowly untouchable Dom caste.

A popular screening device which has been in use in North India from very early times is the cik, a door or verandah curtain made of long thin pieces of split bamboo bound closely together. It acts as an effective Venetian blind, screening out light and flies while permitting a certain amount of air circulation and allowing persons inside the room to see through without being seen from the outside. When full air ventilation is desired, the cik is rolled up and secured at the top of the aperture. The cik is used in front of open-air butchers' stalls, where it has become virtually a trademark (butchers are called "Cik" in some areas). Though it lacks something in deterrent value against the flies, it does somewhat shield the passers-by from the repugnant sight of suspended goat carcases.

Evaporative cooling or lowering the temperature during the hot dry season by adding moisture to the air has also been long practised in India. When women retire to nap on summer days in a dark inner room they often pour water on the floor to lower the air temperature. Spraying water over hot paved courtyards, terraces, sidewalks, etc. at the end of the day is also a common practice to cool the evening air. In fact, this practice has a special name: chirkāc (Bhoj.).

The "khuskhus" screen is still widely used for cooling in North India, despite the increasing sales of air coolers and air conditioners requiring electric power.[1] Air conditioners are not so practicable for many of the old high-ceilinged buildings used as offices, and their upkeep and initial cost (about Rs. 1500 for a small unit which would sell for considerably less in Europe or the U. S. A.) are certainly prohibitive for all but a tiny fraction of the population. A set of khas[2] tatties adequate to enclose a door entrance and a window, on the

---

[1]In this connection, incidentally, I must take issue with D. H. K. Lee's statement that "A type [of 'water blind'] currently used in India, made of a thick mass of millet, is practically useless" (Lee 1963, p. 44). Dr. Lee has failed to mention the ubiquitous khas tatty, whose usefulness surely outweighs its disadvantages in hot-dry conditions. A screen of millet would of course be far less satisfactory, but I doubt that millet plants are very widely used in India for this purpose.

[2]In those parts of the country where khas is not plentiful, coconut fiber is the material of choice.

other hand, can be hand-crafted and installed for about Rs. 30 or 40, and upkeep is only a matter of providing water and the modest salary of a servant or employee to keep the screen wet. Tatties are stored from one summer to the next and can last for several years. Of course, khas tatties--inexpensive though they are in relation to air conditioners--are yet beyond the means of perhaps 98% of the families in North India. They are almost never seen in villages, and in cities they are more used in offices than in private homes. Brown states that three tatties bring a room to 88° F. when the temperature "in the open" is 130° F. (Brown 1948, p.35). It is generally held that the humidity inside the room is raised, and some people find this condition more unpleasant than the dry heat. One authority, however, seems to disagree:

> It is a surprising fact that this [khas screen] does not tend to make the atmosphere of an occupied room moister than when it is just closed up in the ordinary way, but it makes it a number of degrees cooler. (Napier 1943, p. 30)

Certainly the khas tatties do shut out light, which is a handicap in offices.

Intermediate in cost between air conditioning and khas tatties is the "desert cooler", manufactured and sold in India. This is a unit which can fit into a window, containing a fan which blows across a wetted surface of khas or other similar material. Ambler recently found such a unit relatively ineffective in the New Delhi summer, but admitted that it was much too small for the room in which it was used (Ambler 1966, p. 280). These air coolers, available at prices from about Rs. 75 and up, are used in urban offices and homes by those who can afford them and who find the khas tatties inconvenient. The desert coolers do not require constant attendance by servants and are more economical to run and maintain than air conditioners. Indian Defence Science personnel have done research on improved khas-cooling devices, in view of the "botheration and huge recurring expenditure" which they felt were involved with the old-fashioned tatties (Majumdar and Sharma 1959, p. 31). Majumdar and Sharma have reported on a new design, working on capillary action and thus avoiding the necessity for periodic wetting as well as electrical hazards posed by water dripping through the air stream. It is used in conjunction with a 16-inch table fan.

In the hot dry season fans may often have little value:

> Returning to Delhi by plane in the summer, a hot blast of air hits you so hard that you involuntarily step back to escape it. You can imagine the smell of smoke and feel your hair getting singed. Delhi heat is not wet, it is burned dry. It sucks your breath away. It teaches you what a piece of cooked meat must feel like. The big ceiling fans turn endlessly, but what they throw at you is hot air. (Smith 1962, p. 251)

But the fan truly comes into its own, in Delhi as elsewhere, with the arrival of the monsoon. From July through October both the desert cooler and the khas tattie are entirely useless and an approach to comfort during sultry days can be provided only by maximizing air movement, or by air conditioning units which can reduce the moisture content of the air while lowering the temperature. Since the average man has no hope of enjoying the latter, the universal method of aiding the evaporation of perspiration is by increased air movement. As Ambler notes:

> In stagnant conditions, air movement is very important indeed. For instance, the difference between 5 f.p.m. and 40 (one-half m.p.h., and hardly noticeable) is equivalent to some 8°, and makes all the difference between severe discomfort and complete comfort. (Ambler 1966, p. 278)

At higher levels of air speed, however, the relative benefit derived from increasing air movement declines. Thus, in a series of indoor measurements in Singapore (with the dry-bulb temperature at 84.8° F., the globe temperature 85.3° F., and the wet bulb temperature 77.2° F., or a relative humidity of about 72%), Yap found that an increase in wind velocity caused a decrease of only 2 F.° in Corrected Effective Temperature, from CET 80° F. to CET 78° F. (Yap 1956, p. 330).[1]

---

[1]The significance of Effective and Corrected Effective Temperatures is described in Appendix C. It may be noted that an ET of 78° F. is the approximate threshhold of perspiration and discomfort for resting men (Bruce 1960, p. 74). Hence, a mere 2° difference at this level can convey a greatly enhanced psychological and physiological effect on individuals so exposed.

Millions of small hand fans (*pankhīs*) are made and sold each year in North India, mostly the type that is readily constructed from the leaf and stem of one of the fan palms, especially the palmyra palm (*Borassus flabelliformis*). Some of these fans, with up to 400 or 500 sq. in. of fan surface and handles a yard long, are not designed for self-fanning, but rather require a servant or other person to stir the air. Such large fans[1] particularly come into use on occasions when there is a guest, or at mealtime, or when a group of people are collected for some function where it is necessary to sit indoors or where there is little air movement on a sultry day. *Pankhīs* are made by a special caste (again, usually the bamboo-workers) in the areas where the raw material is abundant, and are distributed throughout the country for sale at a price of from about Rs. 2 to Rs. 5, depending on size.

Another popular type of fan is the *benā* (from Skt. *vyajana*, root *vyaj* = to toss about), locally manufactured throughout North India. It is made of plaited strips of bamboo in a 12-inch square. The *benā* may be made by village women of almost any caste who have the skill, or it may be made by men of the caste (usually Dharikar in eastern U. P.) which specializes in bamboo-plaiting and basketry. Often the raw material is dyed in red or green colors and a pattern is woven into the fan. The woven square of the *benā* is fixed to a handle about 16 in. long, after a hollow bamboo section has been threaded onto the projecting part of the handle permitting the *benā* to be twirled by a simple wrist motion. This type of fan is often used in villages for self-fanning, although it also has a specific functional application in certain occupations (grain-parching, goldsmithing, etc.) where a fire must be continually fanned, and it has some religious or ritual associations as well, according to Crooke (1888, p. 38).

Especially during the heyday of the British raj in India, an enormous variety of hand fans were made. Some were painted and covered with pieces of transparent and colorless talc, some were made to fold into a small compass and expand into an almost perfect circle, etc. (Blatter 1926, p. 191). However, since these were mostly devised for ostentatious display by the moneyed class--who now enjoy electric fans or air conditioners--they are not much seen in this day and age.

---

[1] In keeping with Hindi-Hindustani usage, the larger fans are calledby the masculine form *pankhā*, and the smaller ones of the same type by the feminine form *pankhī*.

The old hand-operated swinging punkah can still be seen in out-of-the-way corners of North India, in homes and offices where electric current is not available or where there is a good supply of low-salaried labor. As recently as 1964, for example, the clerical staff of the Varanasi District Medical Officer of Health, housed in a large windowless northern-exposed room in an old building just down the road from a modern air-conditioned cinema and restaurant, were working beneath a huge 12-ft. wide swinging punkah pulled by a caprasi.

For the most part, however, the introduction of electric power throughout urban North India has brought the ceiling fan (also called pankhā in Hindustani) as a replacement of the old-fashioned swinging punkah. The modern ceiling fan costs from Rs. 150 to Rs. 300, depending on size, and many people prefer renting one by the month or the season to buying it outright. All Indian-made ceiling fans in use today have three blades,[1] although an older two-blade model can occasionally be seen (for example, in the palace of the Raja of Jodhpur). The modern straight-bladed ceiling fan is also less effective in producing air movement than earlier models which had ends curved upwards, according to Ambler. But since the latter were found to consume more electric current in operation they have largely been eliminated in the interests of economy (Ambler 1966, p. 276). The speed of the ceiling fan is governed by a wall switch which allows six or seven different speeds up to a maximum of about 220 to 330 r.p.m., depending on size.

It is interesting to note that the urban middle or upper-class home which is likely to be equipped with ceiling fans in bedrooms or living rooms for the benefit of the owners never contains this amenity in the servants' quarters or even in the kitchen, where the servants (and nowadays often the lady of the house herself) are expected to toil in front of a pressure stove or charcoal fire in the stifling heat.[2]

---

[1] Ceiling fans in use in the U. S. A. carry four blades, judging from sales brochures of the leading fan manufacturers.

[2] Sargent cites evidence that the higher rate of "tropical neurasthenia" among women than among men in the Australia of over 50 years ago was directly related to their long hours of confinement inside the house, and especially in poorly-ventilated kitchens with galvanized iron roofs (Sargent 1963, p. 294). My interviews with urban Indian women in Varanasi suggest the probability of some comparable sexual differential in susceptibility to mild heat stress-related disorders of the prickly heat and "neurasthenic" type, for exactly the reasons seen in Australia. But I can offer no statistics to bolster this impression.

The need to maintain an even cooking fire may help excuse the absence of a fan in the kitchen, although Ambler points out that

> The smaller the room, the greater is the need for them, and the lack of fans in some dressing rooms makes them useless for their purpose for quite half the year. In particular, a fan is needed in what is relevantly called "the smallest room". (Ambler 1966, p.276)

The ordinary men and women in North India, and certainly the domestic servants and the working classes, have throughout history been assumed by their betters and rulers to have a special capacity to tolerate extreme heat!

Table model or floor model portable, horizontally-blowing electric fans of the kind well-known in the U. S. A. are being sold in increasing numbers in North Indian cities, but are still used less than the ceiling fan. Some statistics on Indian urban middle and upper middle class ownership of fans were collected by the Indian Institute of Public Opinion in 1963. Some rather striking variations are revealed in this survey among the four major cities of India (Delhi, Bombay, Calcutta, and Madras), although unfortunately the regional influences cannot be entirely separated from socio-economic differences, since the Bombay sample enjoyed monthly incomes in the Rs. 500 to 1000 range, while those of the Calcutta sample were much less: Rs. 100 to 200. Only the Delhi and Madras samples were comparable: Rs. 300 to 500 per month. The results of the survey are shown in Table 2.

Table 2. Percentages of urban samples using cooling devices

	Bombay	Delhi	Madras	Calcutta
Air conditioner	1.2	0.4	0.8	0
Room cooler	0.8	1.2	0	0
Refrigerator	22.8	3.2	4.4	1.6
Ice box	0	4.8	0.8	0.4
Ceiling fan	84.4	73.6	19.2	48.4
Table fan	34.4	38.8	57.2	10.8
Pedestal fan	1.6	4.4	0.4	1.6

Source: Indian Institute of Public Opinion. Monthly Public Opinion Surveys, Vol. IX, No. 2-3 (November-December 1963)

The major difference between Delhi (in North India) and Madras (in South India) lies in the relative dependence on ceiling fans and table fans, and its explanation seems to lie less in climatic differences per se (Madras has virtually no hot-dry season or winter cold season, and is generally hot and humid), than in house and room characteristics, and the history of electrification in India. The Bombay and Calcutta samples contrast maximally in terms of income, whereas their climatic environments are not too dissimilar. Heat stress--largely in hot-humid conditions--is generally a bit greater in Calcutta than in Bombay; yet the total availability of fans is only about half as much, a fact probably attributable atleast as much to the lower level of affluence of the Calcutta sample as to Bombay's overall superiority in modern amenities and technology. It may be noted that 26.9% of the overall four-city sample owned their own homes, while 71.6% rented.

Fans of all types in India have an important use and value beyond that of cooling. That is, they discourage the ubiquitous flies and mosquitoes, although it must be observed that a breed of Indian housefly has been evolved that can navigate remarkably well under conditions that would resemble a hurricane in relation to a human being. Anyone who has lived in an Indian village without electricity in the hot season knows how profoundly underrated are flies as disturbers of daytime repose. Two quotations, separated in time by more than a century, may serve to memorialize the pesky Indian fly:

> But, let me not forget the flies! As one lies wearily tossing about on one's bed, so hot as to tempt one to doubt the possibility of ever getting cool again, these small evil spirits keep one in a continual paroxysm of rage; as the old lady in <u>Punch</u> says:--
>
> "They settles on your noses, and they whizzes
> in your eyes,
> And they buz-wuz-wuzzes in your ears; oh!
> drat them nasty flies",
>
> and you smother yourself by covering your face with a pocket-handkerchief in an attempt to escape them, and throw yourself into a yet more profuse perspiration by endeavouring to capture or kill them, it is needless to add, without the least success. (Majendie 1859, p. 267)

> The monsoon was about to break, and the heat was kilnlike in its intensity. The ceiling fans, at this point, failed. If one opened the windows, they admitted hordes of small, black, malevolent flies; if one didn't, the sweat ran in rivers; one's whole body became an ache and blur of heat. (Moraes 1970, p. 101)

Even screens will not stop the "mango flies", pinhead-sized replicas of common houseflies, which sometimes swarm in uncounted billions and "rush madly into eyes, ears, and nose" (Ashby 1937, p. 59).

4. <u>Water and Ice</u>

Ice has apparently long enjoyed a prestige corresponding to its rarity in North India, for Mrs. Parkes noted in 1850 that in the winter when it was being locally manufactured by entrepreneurs in the open-pan manner described in Chapter II, it was sold in the bazaars at the relatively steep rate of one anna (16 annas = 1 rupee) a pound (Parkes 1850, p. 80). The current attitude is hyperbolically described by an Indian writer, although he is probably describing an essentially urban phenomenon:

> I have never seen a people so mad for ice in the hot season as the inhabitants of the Gangetic plain are. They put up the price of ice in June, even beggars rush for it, and they remind me of the polar bears in our zoos. (Chaudhuri 1965, p. 136)

Today most towns with a population of over 10,000 have an ice factory of sorts, although the output is low in terms of per capita consumption. In the countryside "bazaar towns" the ice is typically produced in a small machine having a daily capacity of only a few hundred pounds. The water in some cases may not be adequately filtered, and it is never boiled to ensure absolute freedom from germs, as guides on tropical hygiene aimed at Western travelers never tire of stressing. Generally, of course, tap water is used if available.

My investigation of ice production in Varanasi in 1963 indicated that three commercial factories were in operation in the city, producing at full capacity during the summer season a total of about 30 tons of ice per day. In mid-winter, however, total production dropped off to about 500 lb. a day, most of this being sold to fish vendors. According to a recent study of four eastern U. P. districts (Deoria, Azamgarh, Ghazipur and Jaunpur), which have a combined urbanization rate of only 3.75% in a combined total 1961 population of 7,832,000, there were only two ice factories in 1964 employing 34 persons and with an annual production valued at Rs. 437,000 (approximately Rs. 0.056 per capita or less than one pound of ice annually per capita (India. Planning Commission, 1964, p. 277). The commercial ice production is an essentially correct measure of total ice consumption in a city such as Varanasi, since only a minuscule fraction of the people have home refrigerators. And even of these, the smallest and least expensive Indian-made models were said in 1963 to have insufficient cooling power to make ice during the hottest days of summer.

Ice is a very elastic commodity in terms of supply and demand in India. During the cooler months of the year it may retail at a fraction of a cent per pound. But during the summer period of peak demand its price rises to several times the normal rate and even at high prices it may not be readily available. For example, in Fatehgarh (Farrukhabad District) during the vicious heat wave of June 1960 when 80 persons, mostly children, died in a city of 100,000 people as a direct result of the high temperatures, ice rose in price from Rs. 2 per maund (82 lb.) to Rs. 20 per maund, according to newspaper accounts (Northern India Patrika, June 16, 1960, p. 1). In Lucknow, during the severe heat wave of June 1966, ice was being retailed on the street at Rs. 0.50 per kilogram, double the previous day's rate (National Herald, June 9, 1966, p. 1). When the Muslim month of fast, Ramadan, falls in the hot season many Muslims like to break their day-long fast by taking an iced drink. Of course, they must pay dearly for ice at this time even if they can obtain it.

In cities, ice is delivered on regular routes by men using cycle-carts (ṭhelās). The iceman purchases one or two blocks of ice, each about 80 lb. in weight, and covers them with gunny sacking. He usually makes both early morning and late afternoon deliveries of ice. Most customers are the street vendors of cold drinks, but they may also include some private homes of families who own small insulated iceboxes. Sometimes the iceman has an assistant who carries smaller chunks of ice on a bicycle to customers off the main route.

From March to October, but especially during the heat waves of May and June, "water trolleys" may occasionally be seen in very large cities. These are a sort of mobile drinking fountain, where ice-chilled or ice-cold water is sold for 2 n.p. (Rs. .02) a glass. It is interesting to note that in the case of sidewalk vendors of cold water the method adopted is to place a block of ice on an open-slatted wooden platform directly above a large clay vessel or metal container of water. This water is cooled by the melting ice and is dispensed to customers (who may take it either in a glass or in their cupped hands) by a dipper.

A few foreign embassies in New Delhi are about the only places in North India where American-type public drinking fountains can be seen. I am indebted to Dr. M. E. Opler for some revealing comments on the unacceptability of the drinking fountain in Hindu culture. He notes that Indians do not usually eat or drink through the lips, but rather take food or liquid directly into the interior of the mouth. This becomes a psycho-physiological pattern, although it may arise out of the Hindu concept of pollution, whereby a person feels thatanything touched by the lips is polluted. Thus, Indians may share a glass or bottle, drinking consecutively from it, but it will be noted that they always hold the container high and let the water fall down into the mouth without the lips touching the vessel. Or more commonly they drink from the cupped hand as the water is poured into it. From a forest stream or a spring where Americans would lie prone and drink up the water with their lips, Indians would invariably fill the hands with water and drink from the hands. Besides his feeling of ritual impurity with regard to drinking fountains, the Indian also somehow does not feel his thirst properly satisfied by drinking from a water fountain (Opler 1969).

Provision of water as a public service to thirsty pilgrims or travelers has long been regarded as an act of religious merit in India. A wealthy man who wishes to make such a philanthropic gesture hires someone (preferably a Brahman, from whom all castes may accept water without fear of pollution) to dispense the water, which is normally poured into the cupped hands of the recipient. During the hot season local schoolboys may, as a project of community service, act as water dispensers at railway stations or pilgrimage sites in this way.

Although iced drinks are obviously popular in summer in North India, ice itself is believed by most people to be a "hot" food which should not be eaten. Informants explain the apparent contradiction by saying that although the sensation of ice in the mouth is cold, its effect when eaten is a "hot" one. ("It is cold outside the body but hot inside the stomach"). This is also the Ayurvedic point of view. The fact remains, however, that iced drinks, ice cream, etc. are really popular only in hot weather. The foreigner with a craving for ice cream or iced drinks in winter in a city such as Varanasi is regarded with wonder, and he is hard pressed to find them in the best restaurants, to say nothing of streetside stalls.

For the great majority of the people on the North Indian plains, ice is in fact scarcely known, for it is not usually available in villages.[1] However, they use an inexpensive and effective method of evaporative cooling of their drinking water, storing it in red earthenware jars. These are full of tiny pores which let water ooze to the outside and evaporate (Cline 1943, p. 111). The jars are made by potters mostly in utilitarian quality in sizes from about two quarts upwards, generally either <u>haudīs</u> or <u>gharās</u> (globular with a large mouth) or <u>surāhīs</u> (more urn-shaped with a neck and small mouth). A typical family replaces its water-jar every year, and great piles of these clay pots or jars are seen in market places especially in March and April every year, where they retail on average at about Rs. 1.50 to Rs. 2.50 each.

[1]This is especially true of most of Bihar and eastern U. P. Dr. J. M. Mahar has informed me, however, that in 1969 he observed an active retailing of "popsicles", or frozen flavored ice on a stick, in a large village in western U. P. The vendor transported these novelties by bicycle (Mahar 1969).

The village or town-dwelling family keeps the water-jar on a brick or mud platform in a shady corner of the inside verandah or courtyard, covered with a saucer or lid. In the summer, the jar rests on a thick bed of wet sand. At 115° F., when even those metal objects inside the house in the shade are painful to the touch,[1] water in a clay jar can be kept at about 60° to 65° F. Although vacuum bottles ranging from pint to gallon capacity are manufactured and sold in India, cost and vulnerability to breakage greatly limit their use, and families traveling by train frequently carry a <u>surāhī</u> fitted into a protective wooden carrying-frame. At Banaras Hindu University in the summer of 1963 it was interesting to me to see each professor or dean (or, rather, his house-servant) carrying his own <u>surāhī</u> of water with him by automobile to the office every morning.

Many villagers near Lucknow were observed to keep the drinking water in their <u>gharās</u> untouched overnight for several hours, believing that this would assure that any "worms" or small organisms in it would die before the water was drunk (Khare 1961, p. 253). However, since the water from wells--and especially from deep wells--is always cool, many people in the Varanasi area prefer in the summer to drink freshly-drawn well water rather than that stored in the clay water-jars. Travelers during the hot weather stop at wells at frequent intervals to refresh themselves. They at least wash the feet and then the head, and then last of all--provided they are satisfied with the quality of potability of the water--they drink some.

North Indians are certainly aware of the importance of a copious intake of liquids in hot weather. And especially in urban conditions, the liquid is often sweetened and flavored. But even among the most impoverished field laborers of the villages, there is a widespread belief that, before drinking water during hot days, one must eat a little

---

[1]This statement may seem difficult to credit, but the American Society of Heating, Refrigerating and Air Conditioning Engineers recognizes 113° F. as the critical level for a hot solid object to produce pain and tissue damage on contact (American Society of Heating, Refrigerating and Air Conditioning Engineers, 1965, p. 104). Metals exposed to direct sunlight will of course rise to much higher temperatures--as much as 167° F. in natural conditions (Allan 1947, p. 442).

gur (crude sugar) or other sweet item; otherwise stomach cramps will ensue. Travelers drink from wells, as they must when thirsty, but they try to take great care in selecting the best source, "best" being defined by criteria rather different from those that an American might use (see Chapter V).

B. Behavioral Adaptations

1. Sleep

All my informants noted a change in their schedule of sleep between winter and summer. In the winter, village women and children sleep indoors, typically in a dark small inner room of the house where the thick mud walls provide the maximum warmth in the absence of any form of artificial heating other than possibly a charcoal brazier (angīthī). We have seen that North Indian village men do not usually sleep inside the women's house, but have a separate building as a sitting and sleeping place, or at least maintain a verandah at the front of the house to serve the same purpose. There are many families, however, especially among the impoverished lower castes and untouchables, who lack not only fuel for warming fires but also adequate clothing or quilts as coverings during the cold nights.[1] At best they may have a gatharī, a kind of thin rag-quilt made up of old odds and ends of worn-out dhotis patched and stitched together. These people must perforce set aside their pride and sleep in family groups huddled together inside their small huts. The widespread Indian village practice of sleeping with the face completely covered has been described by various observers, and it is known to play an important role in the spread of contagious diseases when two or more people share a common cover. This practice is not limited to winter alone, but may also occur whenever mosquitoes are numerous, as in the rainy season (Wiser 1933, p. 69).

Fatigue and the absence of fire, of light, and of warm clothing all combine to limit the scope of evening activities for many people, sending them to an early sleep.[2] This is shown in a quotation from Premchand's

[1] Hopper reported that "lower economic groups", representing some 60% of the population of a typical eastern U. P. village, accounted for over 90% of the illnesses in December, 1954 (Hopper 1955, p. 149).

[2] A survey of the Lucknow village studied by Khare showed that in 1959 only 10 of 116 houses had a kerosene lantern, although presumably most of them used small open earthen saucer-lights (dīyās) (Khare 1961, p. 122).

Mukti-Mārg:

> Because of the cold people . . ., drawing their doors shut, went to bed as soon as it was dark. (Srivastava 1969, p.24)

Villagers often jokingly remark that sex is the favorite indulgence of poor people on winter nights, in ironic and unknowing harmony with Caraka's ancient advice. Many North Indians feel perfectly comfortable sleeping in small, enclosed airless rooms in cool weather, and many deaths occur in winter from carelessly using charcoal braziers in these situations. An experience related by Eskelund, while it concerns Himalayan Sherpas rather than North Indians, illustrates what enormous differences in sleeping condition can be tolerated and preferred by different people. On a trip with mountain Sherpas, he shared a small hut with them which, according to their habit, was kept tightly closed with a wood fire burning. Whenever Eskelund and his interpreter opened the door slightly to get fresh air, the Sherpas cried out that they were freezing. As a result, the pair spent most of the night coughing and weeping, while the mountain people slept comfortably (Eskelund 1960, p. 112).

Although some upper-caste men are inclined to disdain the practice as demeaning, many villagers (an estimated 30 or 40% of the total) arrange a bedding of rice straw (Hind. payāl, Bhoj. puāl) on the floor for winter sleeping, as they find it warmer and more comfortable than the usual string-bed or charpoy (cārpāī). There is a tradition, however, that this change from string-bed to puāl should not take place before the festival of Divali, while the change back should occur no earlier than Holi (Prasad 1961, p. 237). Of course, there is a good practical reason why straw beds should not be arranged before Divali, because that night is celebrated by the setting up of dīyās or lamps throughout the house, and the straw is a fire hazard. However, Divali and Holi are also popular benchmarks of the beginning and end of the cold weather season, as evidenced by the ceremonial cycle. While Divali occurs on average on October 30 and Holi on March 1, they are based on a lunar calendar[1]

[1]The Hindu calendar, the only one in the world treating with true rather than mean movements of the sun and moon, has long baffled Western visitors to India. The subject has been discussed notably by Sewell and Dikshit (1896), Das (1928), Wilson (1937), and van Wijk (1938).

and may therefore vary on the Gregorian calendar up to two weeks on either side of the average date (Planalp 1956, p. 249).

The North Indian villager's sleep regimen reflects changes in the seasonal nycthemeral regime. Sunrise and sunset occur in Varanasi on average at about 6:34 a.m. and 5:25 p.m. during the two cold months of December and January (India. Meteorological Department, 1965, pp. 340-3).[1] Most villagers are in bed by 9 or 10 p.m. in winter and rise about 6 a.m. Children of course go to sleep earlier than adults, but few Indian parents are rigid in this respect and it is not uncommon to see small children awake and enjoying ceremonies or entertainments in the middle of the night. Also, children generally sleep later in the morning than adults, while women, on the other hand, arise from half an hour to an hour earlier than men, since custom and modesty dictate that they make their twice-daily trips to some outlying field or wasteland for latrine purposes under cover of darkness (Planalp 1958, p. 312).

In this connection, it may be noted that only a small fraction, perhaps one in ten, of U. P. and Bihar village homes contain indoor latrines, almost none of the flush type. (As noted previously, the provision of indoor toilet facilities is much more typical of Muslim than of Hindu families). Of course, in a large city such as Lucknow or Patna, the percentage of more or less private indoor toilets may reach about 20% or so while perhaps another 50% make use of communal or public privies.[2]

---

[1]These times are advanced almost 30 minutes as far east as Calcutta, and set back 30 minutes as far west as Delhi, as India has a single time zone.

[2]Although one recent study suggests that an increasing percentage of the population has begun to link flies with thespread of dysentery, and express readiness to use latrines of improved design if these could be made available at low cost (Mukherjee 1961), it seems that most North Indian villagers still prefer their present customs of excretion in open fields, for many reasons that have been revealingly detailed by Hasan (1961, pp. 88-95) and others. For one thing, villagers feel too constricted in an enclosed latrine space (Majumdar 1961), and Hasan reports that some villagers find city latrines so repugnant that they are unable to defecate there for days at a time.

One critical factor is whether or not there live in the community any families of the caste of "sweepers", the untouchables who traditionally empty and clean the indoor latrines, and whether or not these sweepers are still willing to perform this unclean work which has resulted in their despised status. In many places they now refuse to do it.

It is much more difficult to generalize on how urban dwellers adapt to seasonal change, since their housing, occupations and living conditions are so varied. However, nearly all urban residents sleep in an inside room in winter and even indigents and travelers are able to find some shelter for the night in dharmshālās or charitable buildings, in railroad stations, etc.[1] The huge numbers of people to be found on the road in North India, journeying by foot buckboard, bullock-cart, bus or train is a testament to the allure of pilgrimages and religious fairs as well as the centripetal influence of urban centers for purposes of education, employment, trade and litigation.

As noted previously, many outlying residents of the metropolises actually live a quasi-village existence. Probably a majority or urban bastī and jhuggī dwellers, both men and women, still use fields or open spaces for excretory purposes. The regimen of sleeping and waking is thus not very different from that of village life. Among the upper-class professionals, intellectuals and officials, whose working day in many cases does not begin until 10 a.m., there tends to be time for late sleep and considerable leisure. However, nearly all people are accustomed to early rising, and in every town located on the bank of a river there are a few stalwarts who even insist on daily sunrise bathing in the river for religious reasons.

The typical American tendency to sleep later on holidays or non-working days is less conspicuous in India, where the night's sleeping schedule does not appear to vary greatly for different days of the week. One of the reasons for this is probably that the average Indian home is much less private and insulated from its neighbors and the noises and

---

[1] I estimated that over 90% of the 800 fatalities from cold exposure during the December, 1961 North Indian cold wave occurred either among homeless persons or those caught on the road while traveling (Planalp 1966).

activities of the surrounding community than is the average American home. Chaudhuri cites another possible reason:

> The general atmosphere of a Hindu home is one of heavy and listless dullness, which drives the inmates out into the streets at all times of the day. People are always gadding about, putting an intolerable extra burden on the inadequate public transport of the cities. But how could it be helped when the home just chokes? (Chaudhuri 1965, p. 228)

With the coming of the hot summer season and the increasing span of daylight the night hours of sleeping are reduced, until by early June the typical village man or woman arises at something like 4:30 a.m. (women) and 5 a.m. (men), and does not retire until 10 or 11 p.m. (On the longest day of the year--June 21--sunrise is at 5:08 a.m. and sunset at 6:51 p.m. in Varanasi). The men unanimously favor sleeping outside the house on charpoys with a minimum of bedding and usually wearing, as in winter, their normal day clothing. Perhaps their chief concern is to sleep near enough to the family's cattle to watch and guard them (Green 1965, p. 69).

Even in the summer, village women sleep within the confines of the _ghar_, for reasons of security and privacy. Naturally, if an inner courtyard or compound is available they prefer to place string-beds there, under the open sky. But the married women who may be visited by their husbands are constrained by modesty to sleep within the dark inside rooms, or at least in a partitioned corner of the verandah. A few prosperous village families may have _pakkā_ houses with flat roofs allowing beds to be placed on them for sleeping. It is clear that no single sleeping pattern can be described:

> Though sleeping spaces are usually carefully allotted, their use varies according to the time of day, and the season. In fact, there is no consistent pattern among all families of a given caste. The only rule generally followed is that the women always sleep in the most interior part of the house. (_Ibid._, p. 50)

In the cities the problem of comfortable sleep is even more acute, in view of the amount of re-radiated heat from streets and buildings, and of the housing shortage. On summer nights crowds of people can be seen on many city streets even after 11 or 12 o'clock at night, and small children are not excluded from this nocturnal outpouring. At night sleepers crowd available roof tops, balconies and verandahs in large cities and men freely move onto the sidewalks to sleep, with or without their charpoys, if no other open place is available. In some places a late night tour will reveal long rows of street sleepers, each covered from head to toe by a single sheet. At the same time, however, it should be noted that there have been in the past (and still are today) many times and many localities in India where personal safety is felt to be so greatly threatened, especially at night, that people choose to sleep indoors even in summer. Chaudhuri has written of such conditions:

> The common folk expected to be killed or maimed in open brawls. The dread of the gentlefolk was about being killed in bed while asleep or assassinated after dark. The night was generally regarded as a time of extreme insecurity, and so far from sleeping in the open in the hot season, people did noteven keep their windows open. (Chaudhuri 1951, p. 46)

Although the matter was accompanied by not a hundredth part of the press publicity that would have occurred in the U. S. A., the grimy railway junction town of Mughal Sarai, near Varanasi, in 1963 suffered from its counterpart of America's contemporary "Boston Strangler". He was an apparent sexual psychopath, by daytime a respectable shopkeeper, who was finally seized and charged with nearly a score of molestation-murders of young children, all victimized while sleeping in open areas outside their homes. Mahatma Singh, whose exceedingly grim view of the impoverishment of northeastern U. P. has been previously cited, makes the following summation of current conditions:

> In this society every day murders, suicides, dacoity, robbery, cheatings, exploitation of man by man, hatred, ill-will, litigation are practised. (Singh 1967, p. 102)

Informants state emphatically that they never take midday naps in the autumn andwinter seasons. In summer, however, the reduction in night-time hours of sleep combined with the fierce heat during midday does lead most people to the habit of an early afternoon siesta. Even if it is literally too hot to sleep, as may be the case, rest and the absence of any exertion beyond fanning and pouring water over oneself are the preferred practice during heat waves. City streets appear as strangely deserted at one or two o'clock in the afternoon in May as they are full of people at midnight. Rickshaw drivers doze precariously on the seats of their vehicles, and those who are willing to risk their health to take on passengers demand enhanced fares. In villages too there are few signs of human activity in the middle of hot dry summer days. The women retire to a shaded inside verandah or to an inner room whose temperature at this time, intolerable as it might be to an unacclimatized individual, still compares favorably with outside conditions. Men rest on their outside verandah or under a shady tree, usually covering the face with a cloth against the dust and flies. Ashmore has described how English children in India napped in summer under a large swinging punkah while their

> . . . Ayahs roll themselves in their chudders, and stretch their full lengths upon the floor around the children's beds . . . (Ashmore 1841, p. 224)

With the arrival of the monsoon usually in the latter half of June the frequent cloudy, rainy and cool days come as a blessed relief to the parched land and people. These days are regarded as more akin to winter than to summer (even though minimum temperatures rarely fall below 75° F.) and people do not typically nap during cloudy or rainy days nor stay awake until close to midnight. On the hot sultry days when the monsoon is interrupted, however, those who are not tied to an inflexible work schedule may rest or nap in the early afternoon. Since high humidity and lack of wind, rather than extreme temperature and hot wind, are the greatest source of discomfort, those who rest at midday try to avoid the inside rooms and find an open but shady spot where they can take advantage of any passing breeze.

In this season villagers may place their charpoys in an open place at night, but since rain storms can arise with little warning everyone is prepared to pick up his bed quickly, run to shelter and then resume his sleep. Both the larger <u>pakkā</u> village houses and modern urbanflats often include a special room on the roof where the sleeper can retire when rain interrupts his sleep under the stars. However, many people prefer not to sleep in an open place after the rainy season begins, even when it is a warm night. This is because of the exceptionally heavy dews which occur in August and September, which can chill the sleeper with surprising rapidity, and which are intensely, universally and almost irrationally feared in North India.

It is believed that one must arise before dawn and take a bath if he is to avoid the "chills" and sicknesses that seem so prevalent in the season of heavy dews. In the hot dry months also many people take their baths in the morning, immediately after excretory functions. But during the cooler part of the year they generally bathe at noon. The bath is always taken before, not after, the meal. Freshly-drawn well water feels refreshingly cool on hot days, and feels relatively warm in the winter. Hasan found that 43% of village Hindu men near Lucknow bathe daily even in the winter, although none of the village Muslims did so (Hasan 1961, p. 7). However, the definition of a bath is more ritual than functional --merely throwing water on the body may qualify as a bath.

2. Seasonality of Reproduction

At this point it may be of interest to digress slightly and consider the question of seasonal patterns of birth and conception rate in North India. Seasonality of conception seems to exist to some degree in nearly every human society, although the patterns vary considerably. The subject has been most recently and comprehensively reviewed by Macfarlane (1969), some of whose conclusions are as follows:

1. The greatest fluctuation or flux[1] is in the warm temperate to subtropical latitudes of the earth rather than in the subarctic or equatorial regions.
2. Most island populations (Japan is an exception) show a smaller flux than mid-continental groups.
3. Similar temperature changes have different relationships to seasonal conception in different parts of the world, although

[1] "Annual flux" can be illustrated more conveniently than it can be defined. If the average birth rate in the month having the highest birth rate is 10% greater than the annual average birth rate, and the average birth rate in the month having the lowest rate is 10% less than the annual average birth rate, the annual flux is 20%, for example.

the pattern for each region is nearly constant over decades. For example, there is summer depression of conception in the United States, while in Europe and Australia there is a high summer rate of conception and a winter minimum.

4. In spite of increasing control of the microhabitat of man, there has been little reduction of seasonality and in some places the flux has been increasing.
5. The principal trend, although a weak one, over the past 30 years has been that underdeveloped areas have moved towards the more urbanized distribution of seasonal conception patterns. (Macfarlane 1969, p. 181)

Other medical biometeorologists have reported that in tropical and sub-tropical regions of the earth, the conception rate among indigenous and acclimatized residents is at its lowest point during the hottest season, when it is about 25% to 30% less than during the coolest season (Macfarlane 1962, p. 531; Tromp 1963, p. 401).

North India is of special interest in connection with seasonality of conception and birth rate, since its annual flux--up to 50% in some areas--is one of the highest in the world. The subject was first explored in India by S. A. Hill in the United Provinces, the area substantially identical to the present Uttar Pradesh. He used the birth statistics for the 10-year period 1878-1887, when the annual reported birth rate was 45.41 per thousand population. The monthly rates (projected to an annual basis), together with their average deviations from the annual rate, for this 10-year period were as follows:

Month	Annual rate of births (per 1000 population)	Deviation from annual rate
January	44.59	- 1.8%
February	43.84	- 3.5%
March	40.67	- 10.4%
April	39.47	- 13.1%
May	36.11	- 20.5%

Month	Annual rate of births (per 1000 population)	Deviation from annual rate
June	35.43	- 22.0%
July	40.50	- 10.8%
August	50.53	+ 11.3%
September	56.71	+ 24.9%
October	55.71	+ 22.7%
November	51.04	+ 12.4%
December	50.24	+ 10.6%

(Hill 1888, p. 250)

These figures of course show a marked seasonal flux in birth and in conception rates, the former being highest in September-October and lowest in April-May, the latter being highest in December-January and lowest in July-August. Hill explained these differences as follows:

> . . . at the end of the rains the vitality and energy of the people have reached low-water mark. . . . In December, on the other hand, not only is the salubrity of the country greatly increased, . . . but food is again cheap and abundant. (Hill 1888, p. 250)

Mathew (1940-1941) studied the 1926-1938 birth rates in India, being primarily interested in the effect of temperature on conception rate. He found a high negative correlation (- .6971) between monthly average temperature and monthly conception rate. However, no multiple regression was fitted with other factors, not even the meteorological ones such as humidity, diurnal range, etc. The amount of variation not explained by temperature alone is of considerable significance.

The authors of a later study in India warned that any calculations, such as those of Hill, which are based on official vital statistics, can have only a spurious accuracy, for

> The filthy, badly scribbled and often illegible registers (with totals over three figures generally erroneous) which we saw are identical with the form in which the data are sent on to higher authorities, and seem but a poor foundation for the weighty announcements often made by scholars analysing Indian vital statistics. (Kosambi and Raghavachari 1951, p. 178)

Nevertheless, these authors considered Hill's conclusions to be qualitatively correct so far as the seasonal effects on birth rate are concerned. Extending their study to the whole of India, including 52 cities, they concluded that it is not possible to describe a standard all-India birth-rate curve, since there is so much variation in seasonal patterns in different parts of the country. However, they found the areas now substantially included in Uttar Pradesh, Madhya Pradesh and Bihar to be sufficiently similar that they could be grouped together in a single curve.

The most interesting finding of the Kosambi-Raghavachari study was the fact that, at least in western India (Bombay, Poona, etc.), the urban and the rural seasonal patterns of births and conceptions were surprisingly different from each other. Their conclusion was that in cities climate is the major influence affecting birth or conception rate, whereas in villages the climatic effect is indirect, mediated through the demands of the crop regime and the times of harvest plenty. For example, just when the monsoon onset brings pleasant relief to city dwellers, at the same time the peasants are required to exert themselves to their physical limit in plowing, harrowing and sowing, and conception rate falls off at this time. In other words,

> . . . climate has a greater direct influence when the economic conditions are reasonably steady all the year round, as would be expected in a city. In rural areas the influence of the climate may be counteracted by economic conditions, specifically in the energy spent during sowing and harvesting times, which are controlled in India by the monsoon season. (Kosambi and Raghavachari 1951, p. 179)

In connection with the present investigations, and bearing in mind the injunctions against giving full credence to official statistics, I have calculated the average monthly deviation from each year's annual rate for registered births in Uttar Pradesh for the ten years 1951-1960:

Table 3. Average monthly deviations from average annual rate of registered births in Uttar Pradesh, 1951-1960

Month	Rural	Urban
January	- 1.51%	- 4.51%
February	- 3.78%	- 9.57%
March	- 3.20%	- 14.70%
April	- 8.76%	- 17.53%
May	- 12.71%	- 21.50%
June	- 6.02%	- 17.24%
July	- 1.56%	- 0.15%
August	+ 7.15%	+ 17.21%
September	+ 14.08%	+ 26.38%
October	+ 4.49%	+ 19.88%
November	+ 5.41%	+ 15.44%
December	+ 6.41%	+ 6.21%

Source: India. Ministry of Health. Health Statistics of India.

These figures are generally similar to those reported by Hill 70 years earlier, showing only a slight overall reduction in seasonal flux. Calculating, in accordance with accepted demographic practice, an average 9-month difference between conception and birth, the 1951-1960 data indicate August and December to be the months of lowest and highest conception rates, respectively. There is certainly an inverse correlation of dry bulb temperature and conception rate, but it is not perfect, and is indeed more pronounced in the urban than in the rural statistics. Thus, January is the coldest month, but the conception rate in January is lower than that in November (which, being a harvest month, is a time of relative food plenty). So far as average dry bulb temperatures are concerned, August is far from the hottest month in North India--in fact, it ranks fifth. However, it is the month with the highest absolute minimum temperature and the least diurnal range (see Table 1). It may very well be the month of highest average heat stress, calculated by a sentient or effective temperature index which combines dry bulb temperature, humidity, solar radiation and the effects of wind (or the absence of wind). In addition, prickly heat is likely to be at a peak in August, there is probably a factor of accumulated heat fatigue buildup, and this month is one of maximum food scarcity. In combination, these factors probably explain why a nadir point in conception rate in North India is reached in August.

Unfortunately, my present statistical data are open to severe criticism. First, the average annual number of rural births registered in the 1951-1960 decade was 815,556 or approximately 12.7 per 1000 population, while the urban total was 276,413 or 39.3 per 1000 population, making a combined annual registered birth rate of only 14.8 per 1000. These figures reveal a gross under-registration, especially in the rural areas, since the Indian National Sample Survey in 1958-1959 found the actual birth rate in Uttar Pradesh to be on the order of 45 per 1000 population. In other words, only about one in four of all rural births was officially registered in the decade of the 1950's.

Secondly, the possibility cannot be excluded of seasonal factors which might influence the registration or non-registration of births and thus act as a biasing factor in the statistics. Certainly the monthly birth rates, expressed in terms of deviation from what the rate would be if births occurred uniformly throughout the year, show considerable fluctuations from year to year (e.g., between + 3.5% in May 1959 and - 21.8% in May 1954, and between + 28.6% in September

1953 and + 5.1% in September 1959). Urban and rural ratios are also frequently at variance during the same month, the largest differences occurring in April 1953 (rural + 8.72% and urban - 23.23%) and October 1955 (rural + .02% and urban + 30.90%).

Finally, looking at the data for India as a whole, as reported in Health Statistics of India, the 10-year monthly ratios of birth rates show some rather inexplicably large differences between adjoining states of the Indian Union.

It is easy to surmise that the registering or reporting of births might tend to be somewhat adversely affected by certain difficult physical and environmental conditions in the countryside--heat waves, flooding of paths, the pressure of seasonal work, etc. More important, under-registration of births is probably greatest in those months when infant mortality is highest, since there is a natural tendency to fail to report those births where death shortly ensues. But the months which especially fit these conditions range from May to September, and encompass the whole gamut from lowest to highest monthly birth rate. Not only is this the case, but also the urban birth registrations, which are more than twice as complete as the rural, point in exactly the opposite direction. That is, they reveal an even more violent seasonality in conception rate, with their annual flux of 48%, compared to the rural flux of 27%.

Over the short term, the conception rate in any community can be sharply affected by any of numerous natural and man-made abnormalities.[1] As to the long-term patterns of human conception rate in any given region, Macfarlane holds that

> . . . the seasonal flux of conception is a biological phenomenon with considerable inertia, but it does respond to changes of microclimate. (Macfarlane 1969, p. 181)

---

[1]In the U. S. A., for example, compare newspaper reports of the significant increase in births in the northeastern states in August 1966, as a direct reproductive sequel to the enormous power blackout of the evening of November 9, 1965. Macfarlane (1969, p. 178) has discussed the effects of feasts and holidays on conception rate.

In North India, it is clear that the seasonal high heat stress has an inhibiting effect on conception rate, and much more sharply so in cities than in the rural countryside. One physiological mechanism through which this climatic effect may be mediated is that of sperm production, concentration and motility, which have been shown to be significantly decreased at high temperatures (Schreider 1963, p. 63; Roy, Sen Gupta, and Mishra 1964, p. 278; Cupps et al. 1960, p. 212). Macfarlane, however, feels that most of the biological basis for seasonality of conception lies rather in the neuroendocrine, especially the pituitary, hormone responses of the female to the environment, e.g., reduced outputs of thyroxin, cortisol and follicle-stimulating and luteinizing hormones (Macfarlane 1969, p. 180).

Addressing himself specifically to India, Macfarlane believes that the very high annual flux derives primarily from a "relatively unmodified impact of environmental temperatures on the Indian population" (Ibid., p. 180). He further suggests the possibility, as yet unproved, that seasonally inadequate diet may modify the primary environmental effect through reducing pituitary activity. He is, however, far less convinced of a primary effect of diet on conception rate in India than was Ellsworth Huntington. The latter noted that experimental studies on the physiological effects of inadequate diet at Springfield College showed that while a period of under-feeding markedly reduced sexual desire, the sexual interest revived with great strength when a normal or more abundant diet was provided. Huntington then proceeded to theorize that the "sexual excesses of India" might be due to a similar annual cycle of famine and harvest plenty (Huntington 1945, p. 426). Assuming that we can substitute "conception rate" as a less pejorative equivalent of "sexual excesses", it is interesting (even if much too superficial to be conclusive) to place side-by-side climatological tables (Table 1), an annual "dietogram" (Figure 6), and the tables of conception rate in North India (see above). It appears from such a rough comparison that there is a much better inverse correlation of temperature (especially of effective temperature) than of food insufficiency with conception rate.

The subject deserves much more careful study, and is undoubtedly receiving it in connection with current Indian governmental preoccupation with problems of population control. Among the other plausible factors which may need to be considered before we can fully understand the year-to-year aberrations as well as the more long-term seasonal patterns of conception, are the following:

1. regular or irregular occurrences of epidemic and other diseases;
2. the North Indian woman's <u>preferred</u> times of confinement and childbirth (a matter on which I have no information);
3. astrological determinations affecting time of consummation of marriage (probably meaningful, if at all, only in relation to a small minority of orthodox Hindu families);
4. specific seasonal changes in sleeping arrangements and other social activities, insofar as they hinder or facilitate sexual access; and
5. any beliefs, taboos and practices relating to sexual relations and the times of their occurrence.

3. Work

Of the 120 million villagers in the states of Uttar Pradesh and Bihar, perhaps two-thirds of the men and one-fourth of the women are primarily engaged in actual agricultural operations outside the house in the fields. Their work schedule is thus dictated by the seasonal requirements of the crops: preparing the soil, planting, irrigating, weeding, harvesting, threshing, and so on. Naturally, the agricultural work cycle varies from place to place on the North Indian plains, depending upon the subsistence and cash crop regimes in any specific locale.[1] However, for most of the region around Varanasi in eastern U. P. the normal hot-weather activities follow the pattern described here.

---

[1]See Sethi and Sharma (1952) for data on sowing and harvesting seasons for all North Indian crops. The <u>Indian Crop Calendar</u> is the most detailed source for this information. (India. Ministry of Food and Agriculture. Directorate of Economics and Statistics, 1956)

During most of the summer season (April-June), agricultural operations are not ordinarily very demanding. In fact, this is the time of the year when most village marriages are celebrated, since people have relatively more leisure to travel and the large all-male marriage parties which journey to the bride's home can camp in the open for two or three nights without hardship. The principal agricultural requirements in May are hoeing and irrigating sugar cane, harvesting onions, and preparing fields for the rainy season crops by dumping compost and plowing. However, early June, the time of most severe heat stress, can sometimes be an especially trying time for the farmer. This is because it is necessary to sow the rainy season crops--rice, maize, s̃āv̄ã (an early millet, variously identified as Panicum crusgalli, P. frumentaceum, or P. miliare) and sorghum--in the face of a highly unpredictable monsoon, one which is as likely to arrive abundantly or ahead of time as it is to arrive in any combination of delay, insufficiency, or false breakout.

Timing is all-important for the farmer--he may easily sow too early or too late and he must make critical decisions as to when to sow and how to allot his fields among the food and fodder crops, depending in part on his estimate of the availability of moisture at the proper time. Perhaps some sense of this problem may be conveyed by quoting briefly from a diary of village activities that was kept in 1955 by research personnel in village Madhopur in eastern U. P., and especially relating the chronicle of maize planting:

"June 4. Due to the sudden rains, some people are planting fodder crops and s̃āv̄ã millet, but they are not sowing maize for fear the rains may stop.

June 5. Nearly all the rice nursery plots have been seeded.

June 7. Some people are sowing maize, but others are not for fear there will be no rain during the Mriga nakshatra,[1] and insects will devour it.

June 10. Now those who did not sow maize earlier are trying to do so, but are afraid that the continuous rains may prevent them.

June 12. Intensive sowing of maize is going on.

---

[1]Hindus recognize 27 nakshatras or asterisms, astrological divisions of the year which the Indian farmer has long associated intimately with the agricultural cycle. These are described by Grierson (1926, p. 275).

June 17. There is fear that the whole crop will have to be resown due to the stoppage of rain.

June 24. Maize and sugar cane are being hoed. If there are no rains soon it will be necessary to well-irrigate.

June 27. Well-irrigating is increasing.

July 2. Some rain has fallen, the paddy nurseries have been resown, and maize is being hoed.

July 8. Rains have failed, and there is fear the whole kharīf[1] crop will be ruined.

July 12. Maize and paddy nurseries are being irrigated.

July 25. Paddy is being transplanted. Lack of rain is threatening the maize crop.

August 5. Sā̃vā̃ harvesting has started; green maize ears are being roasted.

August 12. Paddy seedlings will die if there is no rain soon.

August 15. Maize harvest is starting.

August 26. Maize is 50% harvested. Winter crop seed beds are being plowed.

September 2. Heavy rains make plowing impossible.

September 4. The maize has all been harvested."

The pertinent factor with respect to the exposure of farm laborers to severe heat strain is the occasional need to irrigate newly-sprouted fields and nursery beds when what appeared to be an early monsoon comes

[1]Fields are generally double-cropped in North India. In official parlance, the kharīf is the rainy-season crop--especially rice, but also including maize, sorghum, millets, sugar cane, etc. The rabī is the winter crop, primarily wheat, barley, peas, mustard, potatoes, etc. In eastern U. P. and Bihar, these general crop categories are in actual practice modified or cross-cut by other specific crop associations, especially bhadaī, agahanī, and caitī, names derived from the lunar month of harvest (see p. xi). For example, bhadaī crops are quick-growing rice, maize, and inferior millets, while agahanī crops are pigeon peas, mũg, and a late rice which requires irrigation. These secondary crop associations, usually grown in interculture, offer the farmer increased protection against the fickle North Indian climate (R. L. Singh and K. N. Singh 1968, p. 91).

to a halt and another two or three weeks of scorching dry weather ensue. The specific techniques of irrigation are numerous and largely manual. The special threat of heat injury which they pose derives from the fact that once the flow is stopped in the glaring white, dusty parched fi . considerable time and water are wasted before it again reach plots being irrigated. Thus there is a tendency on the part of landowners to press their laborers to go on working without letup even in the middle of the day. Also,

> Sometimes the crops must be irrigated very quickly if they are to be saved. The seeds of the summer plants must be planted immediately after the first monsoon rainfall. (Luschinsky 1963, p. 69)

Except for the urgent work demands occasioned by a fickle monsoon, however, the necessary agricultural tasks during the hot summer season are in fact completed on a flexible schedule. That is, the more arduous labor is carried out in the cooler hours of morning and evening if possible, while work and exposure to the sun are largely avoided during the midday period of noon to 3 p.m., when most villagers rest or nap, and paths are deserted. An eminent physiologist's observation that inhabitants of the tropics are careful not to over-exert themselves physically under conditions of high environmental heat seems generally valid for North Indian villagers (Dill 1938, p. 94), but little scientific work has been accomplished to document such assertions (Collumbine 1949-1950). Much work activity of a semi-sedentary and portable type is carried out in hot weather under the large shady trees, such as neem, tamarind, pipal and banyan. The tamarind tree is most preferred because it is "clean", while the pipal and banyan have sweet fruits which attract birds and insects and thus result in annoying droppings.

As to the rural and urban non-agricultural workers in North India, many of them are self-employed or work in very small establishments where daily work schedules may often be adjusted to suit personal convenience. Factory, governmental and other employees typically work an 8 or 9-hour day during most of the year, with a noontime lunch hour or half-hour. During the hot season, however (usually from about April 1 - 15 to September 30, but in some cases limited to the May-June period of peak dry bulb temperature), many employers institute a summer work schedule:

> In India official working hours are enforced every year from 1st of April to 30th of September. (Almast 1963, p. 77)

> The official hot weather in India continued from 15 April to 15 September, except for journeys on the Northwest Railway, when dates were 1 April to 15 October. (Raina 1961, p. 543)

Most frequently, the change is simply one of beginning work an hour earlier in the morning and finishing an hour earlier. In other cases total work hours are reduced during the hot summer season and are limited to the morning, e.g., in the Banaras Hindu University foundries and workshops, from 6 to 11:30 instead of 7:30 to 4.[1] In New Delhi, Miss Lyon found that ". . . the hours which people spent in their offices during the heat were fairly unpredictable . . ." and that considerable somnolence was evident in those offices in the early afternoon (Lyon 1954, p. 100).

As noted, farmers and some other very small or self-employed entrepreneurs--those whose work is in or near their home--may simply take an extended rest at midday on hot days and resume work from about 3 or 4 p.m. and continue into the evening. (Large retail shops and stores in major North Indian cities are normally closed for two or three hours in the early afternoon throughout the year.) However, the large-scale employers--government and private industry--in North India have never been able to persuade workers to adopt this kind of summer schedule, since it would involve either traveling home and returning in the heat of the day or else languishing uselessly at the

---

[1]A timely article in the New York Times describes the summer work schedule in the new Pakistan capital of Islamabad, just west of Indian Panjab, as being between 8 a.m. and 2 p.m. Within an hour after work ends, according to the reporter, the streets of the city are completely deserted (Schanberg 1970, p. 12).

place of work.[1] In fact, the schedule of summer work hours in Bihar and U. P., in government offices at least, tends to show a linear relationship with the size of town or city, as well as with the level of government, from New Delhi (1961 population about 3,000,000, and seat of the Central Government) through Lucknow and Patna (populations 800,000 and 450,000, respectively, and seats of State governments), through the dozens of district headquarters averaging about 50,000 to 100,000 population, down to the typical sub-district (tahsil) centers of 10,000 to 20,000 population. At the lower end of this spectrum the courts, offices and schools are generally open very early in the morning in the summer, and close about noon. At the top level, in New Delhi, government offices keep about the same hours of work throughout the year, while the two intermediate levels of urban and governmental complexity also show intermediate features in environmental adaptation.

School sessions in India from elementary school to college begin about July 15 and end about May 1, thus allowing vacation during the time of greatest heat. But many village primary and city nursery schools have only morning classes between about March 15 or April 1 and September 30 or October 15.

Probably the most important, and certainly the most dramatic, seasonal landmark in North India is the arrival of the southwest monsoon in June or early July. As a recent American textbook on the country succinctly states:

> Man's life in India is governed by heat and rains.
> (Frykenberg 1968, p. 12)

No other single element can rival water, by reason of its frequent departure from normal times and amounts of availability, as a direct or indirect determinant of the life or the death of millions of people in North India. It is no wonder that the first part of the monsoon has

---

[1]Studies in North Africa of industrial accident rates in relation to season have shown that they reach a peak during the hot season. Contrary to what one might expect, however, the accident frequency is at a maximum not at the time of greatest heat, but rather during the morning shift (4 a.m. to noon). This is attributed, above all, to the maximum disruption of biological rhythms at this time (Lambert 1962, p. 529).

taken on deep connotations in Indian culture of reawakening, joy, and romance, which can only be compared to those of Spring in the temperate climes. This is the Hindu month of Asarh, when in folklore and tradition feminine hearts are deeply stirred by romantic feeling. So far as actual behavior is concerned, the first rains are welcomed by Indians:

> . . . the heat stored up in the baked earth is greatly reduced by the effect of the rain, and this brings an immediate measure of relief. (Sperling 1969, p. 58)

> . . . the first monsoon rain in Delhi is an occasion for celebration. Indians undress and stand in the downpour, laving their skins to rid it of the inevitable prickly heat . . . (Trumbull 1957, p. 13)

The work schedule during the rainy season depends largely upon the occupation. Before long the incessant monsoon rains convert lower-lying fields into vast sheets of water, village paths are slippery with mud, and the area around the house where the cattle are tied becomes a quagmire. Especially severe rains melt away exposed parts of the house walls and cause poorly-protected houses to collapse. During the hot humid season in Varanasi district a great variety of agricultural activities occur: transplanting rice seedlings, plowing fields for the winter crops, harvesting <u>sãvã</u> millet, maize, and <u>urad</u> pulse, and processing the hemp fiber of the <u>san</u> plant. In farming, cottage industry, and the like, the individual is able to follow a flexible schedule, based on his own inclination and whether the day is a cool rainy one or a hot steaming one. The work schedule during the humid and sticky months of August and September must take into consideration the fact that this is the peak season for a variety of fevers and sicknesses.

Indian villagers look upon the final stages of the monsoon with a dislike, a fear and a trepidation that rivals the pleasure with which they welcomed its beginnings. This undoubtedly derives from the frequency of fevers, especially malaria, at this time. But it is commonly verbalized in terms of a hot-cold dichotomy. That is to say, people feel that at this season they may be subjected to successive extremes of heat and cold, which are very dangerous for health. The very name in Hindustani for malaria--<u>jāṛe</u> <u>kā</u> <u>bukhār</u> or "coldness fever", indicative of its recurrent chills--is consonant with the season.

When men return from working in the sun, their heads protected by a wrapped cloth, they are careful not to remove the headgear immediately, no matter how hot they feel, lest the sudden contrast with the cooler air induce illness.

4. Meals

The following figure is an attempt to illustrate some typical differences in the meal schedule in North India between the two seasonal extremes of winter and summer, taking for the sake of simplicity the early January and the late May periods as represenative of each season (see Figure 4). This graph in part also indicates something of sleep regimens and caloric intake among both men and women, and between two contrasting socio-economic groups. I am well aware that the range of variation from one individual, one family or one village--to say nothing of one region--to another is in fact so great as to make this kind of estimate almost meaningless. Certainly, it should be immediately noted that the figure aims to be more a modal than an average representation, and that it applies specifically to rural areas surrounding Varanasi in eastern U. P., and especially the village of Madhopur some 20 miles north of Varanasi. However, it seems worthwhile to attempt a first approximation at the modal values or norms for this important dimension of rural life, in view of the dearth and confusion of published literature. The only study along this line that has come to my attention is that of Behura, who generalizes that the number of meals varies from two to four in rural India, and is usually three. Caste, community, season, region--these are but a few of the influences which tend to determine meal numbers and times. He makes one pertinent observation:

> During summer or during agricultural operations, the number of normal meals goes up in some places. (Behura 1962, p. 114)

That is, the longer daylight hours (in summer) and higher expenditure of physical energy (on any given day) are the two determinants of more frequent meals (and in the latter case, presumably, of a higher calorie intake).

At one extreme, Burridge speaks of the large number of U. P. police constables who refused to eat more than once a day, claiming that their health and strength depended on this rule (Burridge 1944, p. 85). At the other extreme, Hasan found that rural children in the Lucknow area typically snacked between meals, and thus could be said to eat at least four or five times a day, even though most adults had only two principal meals (Hasan 1961, p. 143). Some North Indian groups, such as the Tharus of the marshy sub-Himalayan tarāī, are described as having a very strong sense of mealtime regularity. The Tharus eat a breakfast of boiled rice, a lunch of boiled rice-water, and a substantial evening meal of rice, pulses and meat (Singh 1956, p. 162). As another example, the aboriginal Gond and Bhumia of the eastern Mandla region of Madhya Pradesh (about 200 miles south of Allahabad) also eat three meals a day, but for most of the year the hours chosen are, surprisingly, 11 a.m., 4 p.m. and 9 p.m. (Fuchs 1960, p. 63). Only during the monsoon season, because their hours of work are changed, do they follow the more usual timing of a 3-meal schedule: early morning, noon and late evening. Their diet is described as monotonous in the extreme: millet gruel for the first two meals, and dry-boiled rice or millet with vegetables for supper.

However, both these examples are marginal peoples in North India, and there seems little doubt that the most typical meal-time pattern for villagers here is two fairly regular meals, at about noon and an hour or two after sunset. The evening repast is usually the more substantial, while in the case of poorer people the noon meal may be nothing more than a few handfuls of parched cereals or pulses, often with gur, some time during the morning.[1] Families that are relatively prosperous may have two large meals plus a good breakfast. But even here the women seldom go to the trouble of full-scale cooking in the morning, and the breakfast consists of leftovers or "snacks" such as parched grains brought from the village grain-parcher. In all cases, North Indian children generally appear to be allowed exceptional latitude in between-meal snacking (Khare 1961, p. 292), and their insatiable forays on whatever is seasonally available and remotely edible (more often unripe than not) among fruit-bearing trees in the vicinity are legendary.

---

[1]Mahatma Singh estimates that roughly four million people in north-eastern U. P. have no more than one meal a day and liveon the verge of perpetual starvation (Singh 1967, p. 102).

24-HOUR CLOCK OF MEAL AND SLEEP SCHEDULE
(RURAL AREAS NEAR VARANASI)

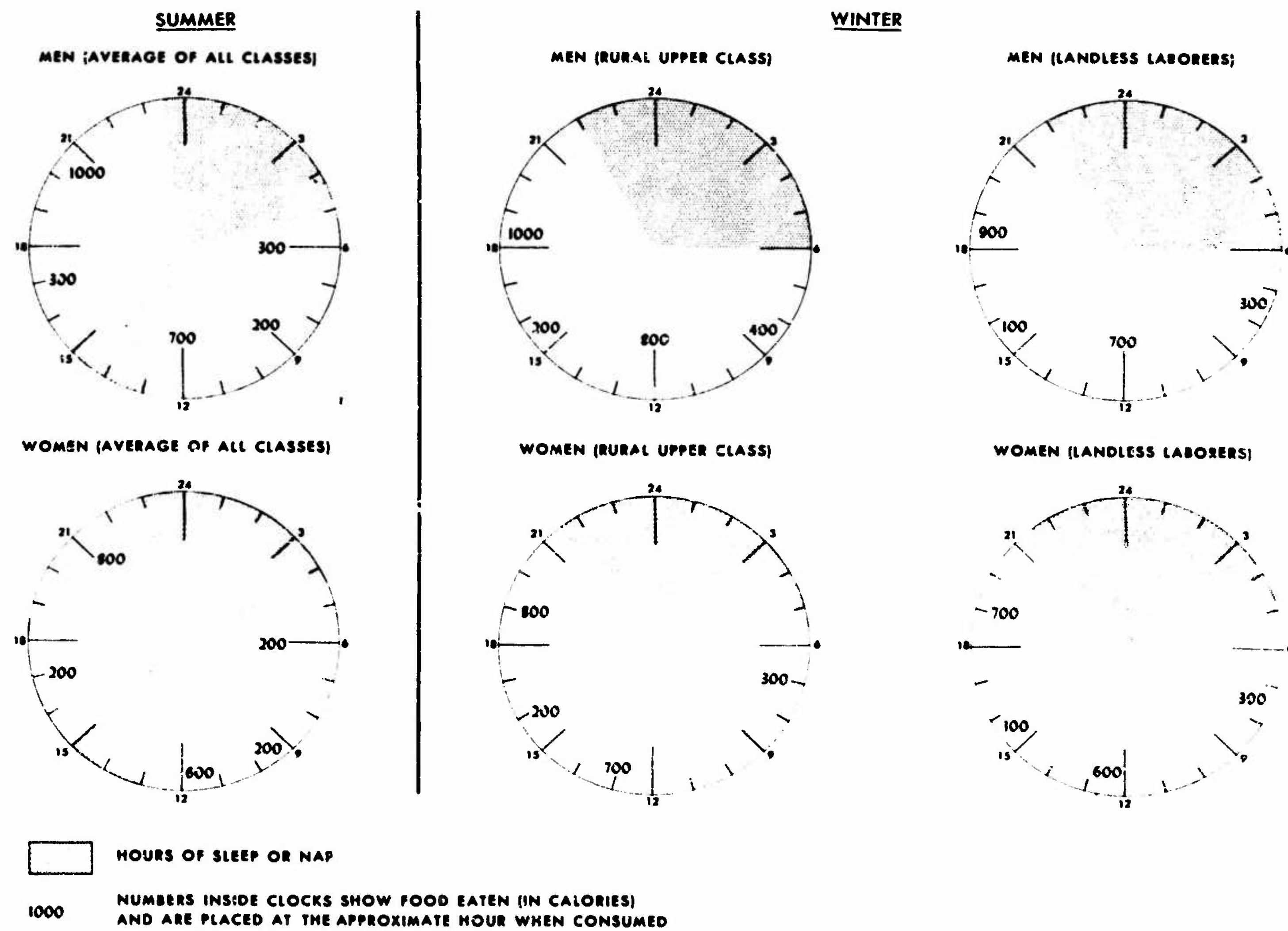

Figure 4. 24-hour Clock of Meal and Sleep Schedule

Available descriptions of the ritual aspects of orthodox Hindu kitchens, and of home food preparation and consumption at least among the village upper-caste gentry,[1] are sufficient to explain why the number of formal meals tends to be kept to a minimum. Pollution concepts are very elaborate and complicated, while the religious and emotional concern about pollution, although slowly weakening, is still of overweening importance in orthodox households. The whole kitchen and hearth area must be plastered over after each use, and eating itself is a sacramental act. There are not a few North Indian housewives who spend 12-hour or even 16-hour days devoted to food processing and preparation.

One may compare the typical allocation of daily calories in one part of North India, as approximated in Figure 4, with that recommended in hot environments by professional nutritionists. Thus, Milev and Weibelzahl believe that 25% of the day's calories should be eaten in a hearty early breakfast, with 30-35% at supper, but only 20-25% at the noon meal. The remaining 20% should be divided, in their opinion, between a morning snack and an afternoon snack (preferably of fruit), as well as a snack before bedtime if late in going to bed (Milev and Weibelzahl 1966, p. 612).

Informants intimately acquainted with village life in the Varanasi region agree that there is very great flexibility in the farmer's daily routine. On the night of some socio-religious function (a festival, a wedding, an entertainment) the women and/or the men, together or more often separately, may be awake and active the whole night. (Many a foreigner invited to an Indian wedding has failed to sit through to its conclusion in the early morning hours). Food is also frequently eaten at very irregular hours. Even the normal supper hour among the farmers in one village, for example, may be around 8 p.m. while in another village not many miles away it may be closer to 10 p.m., for no definable reason except established habit, perhaps following the personal idiosyncrasy of a dominant family.

The difference in body size between adult men and women of course dictates a difference in average total caloric intake. We are in need of more sensitive dietary analyses, which would also indicate the role

---

[1]See, for example, Khare 1961, Luschinsky 1962, Reymond n.d., and C. Wiser 1955.

of cultural factors. Certainly, many North Indian women follow a moral ethic which assigns priority in the allocation of scarce protein-rich and fat-rich foods to the men and the children, especially the boys. "We think that we women should take the coarser foods and give the fine, less coarse things to the men", village women often say.[1] Cultural factors are certainly evident in Figure 4 with respect to the schedules of eating and sleeping. Women observe a practice hallowed in Hindu sacred writings and serve food to their men first, deferring their own meals until after the men have eaten (C. Wiser 1929, p. 371). As has been noted, women also arise earlier than men in the morning.

It is true that few Indian villagers are familiar with the minuscule details of Ayurvedic text and lore, and furthermore that the kind and degree of influence of the old traditions are innumerable. As an example, note that Ayurveda holds that the catarrhal or phlegmatic humor (Kapha) builds up during the winter, and also that it is relatively greater in young people, and in the morning hours of the day. And since there is also thought to be an accession of Kapha during meals, one might not be surprised if there were a tendency for school-children in the cold season not to be provided much in the way of a breakfast. However deplorable by modern dietetic standards, this is a not uncommon situation in India, even if it is essentially due to poverty rather than to the Ayurvedic philosophy.

Most of the North Indian college population, and even many boys of high school level, live in hostels where food is provided by various arrangements. In rural areas, the students usually bring from their own homes the wheat flour, rice, pulses, and oil or ghee which constitute

---

[1]An intriguing aspect of North Indian foodways that deserves better study is the fact that certain foods and dishes are known as "women's foods". These are thought to be especially liked by women and, apparently, especially suitable to them (see Planalp 1956, p. 344). Occasionally women cook these dishes for themselves alone, without telling the men. The adjective most frequently used to describe the taste especially favored by women is caraparā, which means "spicy" or "pungent".

the overwhelming bulk of their diet.[1] At Banaras Hindu University, each of the hostels is independently organized with respect to food provisioning. A cook, usually referred to by the term mahārāj (literally, "great king" or "Highness"), undertakes a contract to prepare and serve the meals, on the basis of a specified monthly charge to each student. Hostel feeding structure and dynamics in a "national" university such as B. H. U. deserves social scientific study, involving as it does the interaction of complex sociocultural and psychological factors. Attempts to satisfy the food tastes of a large group of boys of different regional, religious, caste and family backgrounds is predictably a source of continuing frictions, often solved by setting up a revolving committee to make decisions. But sometimes this whole system breaks down, and messing-coteries of smaller, more homogeneous groups of students emerge. This homogeneity may reflect aspects or region of origin, religion, caste, vegetarianism or non-vegetarianism, or the like, but often it is based on economic considerations, the amount of money the boy or his family is willing to spend on food. Thus, in a group of university hostels there might be a number of mess-groups, each with its own Maharaj, paying rates (in 1964) of from Rs. 50 to Rs. 90 a month, but with an average of about Rs. 70.

Incidentally, lest a figure such as Rs. 50 or Rs. 70 seem incredibly low for a full month's student board (including at least two main meals, plus morning and afternoon tea along with "biscuit" and fruit), the reader may be interested to know that, among the many

[1] Ghee (ghī) or clarified butter is the traditionally preferred--in fact, religiously sanctified--flavoring sauce in cooked dishes, as well as frying medium, in North India. But today one must say dēshī ghī or "country ghee" in order to specify this product, and the word ghī alone is popularly taken to mean any of the various commercial cooking oils made from peanuts, cottonseed, etc. (although technically they are described in Hindi as vanaspati). Few people today can afford to use dēshī ghī, which in 1964 cost from Rs. 6.50 to Rs. 10.00 per kilogram (depending upon quality) in the retail market, whereas Dalda and similar vanaspatis sold for about Rs. 3.00 per kilo.

specifications meticulously detailed in an Indian railway timetable are the following, which describe a so-called "Cheap Meal" or "Janata Meal" ("Janata" is better translated as "People's") offered in all Northern Railway station refreshment rooms:

"(a) Vegetable (1 Katori)
(b) Dal (1 Katori)
(c) Rice or 6 Chapaties (28 gms. each)
(d) Chutney" (Northern Railway 1963, p. xvii)

Although a katorī is a brass container whose size varies somewhat, it usually contains about 2/3-of a cup. The boiled rice serving is 345 gms. in weight, and this complete vegetarian meal costs only Rs. 0.75, equivalent in 1963 to U. S. $ 0.16!

Traditionally, North Indian school hostels for both boys and girls have been more rigidly controlled than is presently the case at large universities, and they have long constituted a convenient captive population sample for dietary studies. Govil, Mitra and Pant (1953) carried on such a study in 14 hostels throughout Uttar Pradesh between 1949 and 1951.[1] These were primarily rural hostels at the "inter-college" or high school level. Their finding of particular interest here was the meal schedule, which consisted of two principal meals, one at about 9 - 10 a.m. and the other at 7 p.m. (on average, presumably). Only a few students ate a nāshtā or light snack early in the morning, although virtually all had afternoon tea, accompanied by fruit or snacks. This general student meal schedule may still be typical of some rural secondary school hostels, but at universities the midday meal is at noon.

---

[1]They limited the inquiry to a week in each hostel, claiming somewhat defensively that ". . . the diets in the kitchens of the hostels do not vary much with seasons and the results of even a short survey of seven days at one season are a fair index of food intake throughout the year" (Govil, Mitra and Pant 1953, p. 3).

LIST OF REFERENCES

Agarwala, K. S. 1950. "Sizes and shapes of hailstones in India", Indian Journal of Meteorology and Geophysics, Vol. 1, pp. 309-311

Ahmed, Zahir. 1965. Dusk and Dawn in Village India. New York: Frederick A. Praeger

Allen, R. 1947. "Electrical engineering problems in the tropics", Beama Journal, Vol. 54, pp. 442-447

Almast, S. C. 1963. "Surgery in summer", Punjab Medical Journal, Vol. 13, pp. 77-94

Ambler, H. R. 1966. "Conditions of thermal comfort in North India", Journal of Tropical Medicine and Hygiene, Vol. 69, pp. 275-281

American Society of Heating, Refrigerating, and Air Conditioning Engineers. 1965. ASHRAE Guide and Data Book for 1965 and 1966. Fundamentals and Equipment. New York: ASHRAE

Ashby, Lilian Luker. 1937. My India. Boston: Little, Brown and Co.

Ashmore, Harriette. 1841. Narrative of a Three Months' March in India. London: R. Hastings

Atkinson, G. Anthony. 1950. "Building in the tropics", Journal of the Royal Institute of British Architects, Vol. 57, pp. 313-320

Balfour, Edward. 1885. The Cyclopaedia of India and of Eastern and Southern Asia. London: B. Quaritch (3 vols.)

Basham, A. L. 1963. The Wonder that Was India. New York: Hawthorn Books

Behura, N. K. 1962. "Meals and food habits in rural India", Bulletin of the Anthropological Survey of India, Vol. 11, pp. 111-138

Bhattacharjee, R. N. 1965. Influence of Climate on the Planning of Residential Areas with Particular Reference to the Hot-Humid Climate of Madras Region. Post Graduate Diploma in Housing Thesis, School of Planning and Architecture, New Delhi

Biswas, Suhas K. and Behura, N. K. 1961. "Types of cottages", pp. 7-16 in Peasant Life in India: a Study in Indian Unity and Diversity (N. K. Bose, ed.). Calcutta: Anthropological Survey of India

Blatter, Ethelbert. 1926. The Palms of British India and Ceylon. London: Oxford University Press

Borden, Daniel L., Waddill, James F., and Grier, George S. III. 1945. "Statistical study of 265 cases of heat illness", Journal of the American Medical Association, Vol. 128, pp. 1200-1205

Brayne, F. L. 1944. Socrates Persists in India. Bombay: Oxford University Press

Brown, Hilton. 1948. The Sahibs. London: William Hodge and Co.

Bruce, W. 1960. Man and his Thermal Environment. Ottawa: National Research Council, Canada. Division of Building Research (Technical Paper No. 84)

Burridge, William. 1944. Climate and Labour. Allahabad: Kitabistan

Chaudhuri, Nirad C. 1951. The Autobiography of an Unknown Indian. London: Macmillan and Co.

_____. 1965. The Continent of Circe. London: Chatto and Windus

Cline, Marie I. 1943. Meet India. Albuquerque: University of New Mexico Press

Collumbine, H. 1949-1950. "Heat production and energy requirements of tropical people", Journal of Applied Physiology, Vol. 2, pp. 640-653

Crooke, William. 1888. A Rural and Agricultural Glossary for the North-West Provinces and Oudh. Calcutta

Crowden, Guy P. 1947. "The control of re-radiated solar heat by whitewash", Transactions of the Royal Society of Tropical Medicine and Hygiene, Vol. 40, pp. 362-364

Das, Frieda Hauswirth (Mrs. Sarangadhar). 1930. A Marriage to India. New York: The Vanguard Press

Das, Sukumar Ranjan. 1928. "Seasons and year-beginnings of the Hindus", Indian Historical Quarterly, Vol. 4, pp. 653-666

Das Gupta, Pranab Kumar. 1961. "Men's dress", pp. 35-40 in Peasant Life in India: a Study in Indian Unity and Diversity (N. K. Bose, ed.). Calcutta: Anthropological Survey of India

Deshpande, R. S. 1935. Cheap and Healthy Homes for the Middle Classes of India. Kopargaon: the author

_____. 1939. Modern Ideal Homes for India. Poona: the author

Eskelund, Karl. 1960. The Forgotten Valley. New York: Taplinger Publishing Co.

Fabri, Charles. 1963. An Introduction to Indian Architecture. Bombay: Asia Publishing House

Fayrer, Joseph. 188?. On the Climate and Fevers of India. London: J. and A. Churchill

Field, J. H. 1934. "The meteorology of India", Journal of the Royal Society of Arts, Vol. 82, pp. 784-806

Frykenberg, Robert E. 1968. India. Boston: Ginn and Co.

Fuchs, Stephen. 1960. The Gond and Bhumia of Eastern Mandla. Bombay: Asia Publishing House

Ghose, Benoy. 1953. Primitive Indian Architecture. Calcutta: Firma K. L. Mukhopadhyay

Ghurye, G. S. 1951. Indian Costume. Bombay: The Popular Book Depot

Gopal, Ram. 1959. India of Vedic Kalpasūtras. Delhi: National Publishing House

Gould, Harold. 1965. "Lucknow rickshawallas: the social organization of an occupational category", International Journal of Comparative Sociology, Vol. 6, pp. 24-47

Govil, K. K., Mitra, D., and Pant, K. C. 1953. "Dietary habits of school boys in Uttar Pradesh", The Indian Medical Gazette, Vol. 88, pp. 1-14

Green, Charles. 1965. "House and home", pp. 43-50 in The Rural Habitat (David Oakley and K. Raman Unni, eds.). New Delhi: The School of Planning and Architecture

Hasan, Kwaja Arif. 1961. Social and Cultural Factors Affecting Health in a Rural Community. Ph. D. Dissertation, Lucknow University

Hill, S. A. 1888. "Life statistics of an Indian province", Nature, Vol. 38, pp. 245-250

Hopper, W. David. 1955. "Seasonal labour cycles in an eastern Uttar Pradesh village", The Eastern Anthropologist, Vol. 8, pp. 141-150

Huntington, Ellsworth. 1945. Mainsprings of Civilization. New York: John Wiley and Sons

India. 1961. Census of India, 1961

India. Meteorological Department. Director General of Observatories. 1965. The Indian Ephemeris and Nautical Almanac for the Year 1966. Calcutta: Government of India Press

India. Ministry of Food and Agriculture. Directorate of Economics and Statistics. 1956. Indian Crop Calendar. Delhi

India. Ministry of Health. 1951+. Health Statistics of India. Delhi (annual)

India. Ministry of Works, Housing and Supply. Comfort Survey Committee, National Buildings Organisation. 1957. Report on Low Cost Housing. New Delhi: Government of India Press

India. Planning Commission. 1964. Report of Joint Study Team, Uttar Pradesh (Eastern Districts). Delhi.

Indian Institute of Public Opinion. 1963. "Urban consumer preferences", Monthly Public Opinion Surveys, Vol. 9, Nos. 2-3, pp. 1-64

Khare, R. S. 1961. Domestic Sanitation in a North Indian Village. Ph. D. Dissertation, Lucknow University

Kosambi, D. D. and Raghavachari, S. 1951. "Seasonal variation in the Indian birth-rate", Annals of Eugenics, Vol. 16, pp. 165-192

Ladell, W. S. S. 1955. "Physiological classification of climates", Proceedings of the International West African Congress. Ibadan, Nigeria, 1949. Jos: The Department of Antiquities

Lambert, Georges E. 1962. "Research needs in tropical climatology", pp. 529-530 in Tropical Health. Washington, D. C.: National Research Council. National Academy of Sciences. Division of Medical Sciences

Lee, Douglas H. K. 1958. "Proprioclimates of man and domestic animals", pp. 102-105 in Climatology. Reviews of Research. Paris: UNESCO

_____. 1963. Physiological Objectives in Hot Weather Housing. Washington, D. C.: Housing and Home Finance Agency

_____. 1964. Heat and Cold Effects and Their Control. Washington, D. C.: U. S. Department of Health, Education and Welfare. Public Health Service (Public Health Monograph No. 72)

Leix, A. 1940. "Indian costumes", Ciba Review, No. 36, pp. 1282-1311

Luschinsky, Mildred Stroop. 1962. The Life of Women in a Village of North India: a Study of Role and Status. Ph. D. Dissertation, Cornell University (University Microfilms No. 63-749)

_____. 1963. "Problems of culture change in the Indian village", Human Organization, Vol. 22, pp. 66-74

Lyon, Jean. 1954. Just Half a World Away. New York: Thomas Y. Crowell

Macdonell, Arthur A. and Keith, Arthur B. 1912. Vedic Index of Names and Subjects. London: J. Murray (2 vols.)

Macfarlane, W. V. 1962. "Research needs in the field of tropical climatology", pp. 531-532 in Tropical Health. Washington, D. C.: NRC. NAS.

_____. 1969. "Seasonality of conception in human populations", pp. 167-182 in Biometeorology, Vol. 4, Part I (Proceedings of the 5th International Biometeorological Congress, Montreux, 31 Aug. - 6 Sept. 1969) (S. W. Tromp and W. H. Weihe, eds.). Amsterdam: Swets and Zeitlinger N. V.

Macfarlane, W. V., Pennycuik, P. R., Yeates, N. T. M., and Thrift, E. 1959. "Reproduction in hot environments", pp. 81-95 in Endocrinology of Reproduction (C. W. Lloyd, ed.). New York: Academic Press

Mahar, James M. 1969. Personal communication

Majendie, Vivian Dering. 1859. Up Among the Pandies. London: Routledge, Warne, and Routledge

Majumdar, N. C. and Sharma, R. N. 1959. "Design and performance of a new room cooler", Defence Science Journal, Vol. 9, pp. 31-37

Majumdar, N. 1961. "Excreta disposal in rural India", Indian Journal of Public Health, Vol. 5, pp. 32-35

Mathew, N. T. 1940-1941. "The influence of seasons on human reproduction", Sankhya, Vol. 5, pp. 261-268

Mayer, Albert. 1958. Pilot Project, India. Berkeley and Los Angeles: University of California Press

Mazumdar, Bhakat Prasad. 1960. Socio-economic History of Northern India (1030-1194 A. D.). Calcutta: K. L. Mukhopadhyay

Milev, N. and Weibelzahl, H. 1966. "Ernährungsphysiologisch und-soziologisch begründete Erfordernisse an die Nahrung des unter den Bedingungen erhöhter Temperatur stehenden Menschen", Ernährungsforschung, Vol. 11, pp. 600-620

Molnar, G. W., Towbin, E. J., Gosselin, R. E., Brown, A. H., and Adolph, E. F. 1946. "Water, salt, and heat exchange of men in tropical and desert environments", American Journal of Hygiene, Vol. 44, pp. 411-433

Moraes, Dom. 1970. "An Indian expatriate rediscovers India", New York Times Magazine, Febr. 15, 1970, pp. 27-107 passim

Mukerjee, Radhakamal. 1940a. Man and His Habitation. London: Longmans, Green and Co.

_____. 1940b. "Ways of dwelling in the communities of India", Asia, Vol. 40, pp. 287-442 passim

Mukerji, A. B. 1967. "Musalman house type in Meerut rural area", Folklore, Vol. 8, pp. 116-130

Mukherjee, S. 1961. "How to popularise latrines in Indian villages", Indian Journal of Public Health, Vol. 5, pp. 27-29

Napier, L. Everard. 1943. The Principles and Practice of Tropical Medicine. Calcutta: Thacker, Spink and Co.

National Council of Applied Economic Research. 1966. All India Consumer Expenditure Survey. New Delhi: NCAER

The National Herald (Lucknow)

The Northern India Patrika (Allahabad)

Northern Railway. 1963. Northern Railway Time Table. New Delhi

Olgyay, Victor. 1963. Design with Climate: Bioclimatic Approach to Architectural Regionalism. Princeton: Princeton University Press

Opler, M. E. 1969. Personal communication

Parkes (Parlby), Mrs. Fanny. 1850. Wanderings of a Pilgrim. London: P. Richardson

Perti, B. L. and Lal, B. B. 1955. "A reliable physiological index for evaluating summer clothing", Nature, Vol. 175, p. 947

Pittman, G. P. 1951. Village India. London: Marshall, Morgan and Scott

Planalp, Jack M. 1956. Religious Life and Values in a North Indian Village. Ph. D. Dissertation, Cornell University (University Microfilms No. 56-979)

_____. 1958. "Social values and patterns of living", pp. 307-340 in Area Handbook for India. New Haven: Human Relations Area Files (typescript)

_____. 1966. Cold Injuries in the Tropics: the North Indian Cold Wave of 1961. Natick, Mass.: U. S. Army Research Institute of Environmental Medicine (unpublished manuscript)

Prasad, B. G. 1961. "Some common beliefs and customs in relation to health and disease in Uttar Pradesh", The Antiseptic, Vol. 58, pp. 225-238

Prasad, Narvedeshwar. 1968. "Solar altitude and planning of urban architecture in Ganga valley, India", p. 351 in 21st International Geographical Congress. Abstracts of Papers (Sivaprasad Das Gupta and Teresa Romanowska-Lakshmanan, eds.). New Delhi

Raina, Bishen Lal (ed.). 1961. Official History of the Indian Armed Forces in the Second World War 1939-45. Preventive Medicine (Nutrition, Malaria Control and Prevention of Diseases). Delhi: Combined Inter-Services Historical Section, India and Pakistan

Rajalakshmi, C. R. 1961. "Women's dress", pp. 41-48 in Peasant Life in India: a Study in Indian Unity and Diversity (N. K. Bose, ed.). Calcutta: Anthropological Survey of India

Rama Rau, Santha. 1944. Home to India. New York and London: Harper and Brothers

Renbourn, E. T. 1962. "Tropical clothing. A physiological appreciation", pp. 91-98 in Biometeorology (Proceedings of the 2d International Bioclimatological Congress, London, 4-10 September 1960) (S. W. Tromp, ed.). Oxford: Pergamon Press

Reymond, Lizelle. n.d. (1961?) My Life with a Brahmin Family. New York: Roy Publishers

Roller, W. L. and Goldman, R. F. 1967. "Estimation of solar radiation environment", International Journal of Biometeorology, Vol. 11, pp. 329-336

Roy, A., Sen Gupta, B. P., and Misra, M. S. 1964. "Effect of varying environment on semen quality, cardio-respiratory activity, milk production and female fertility of buffalo", pp. 375-288 in Environmental Physiology and Psychology in Arid Conditions. Proceedings of the Lucknow Symposium. Paris: UNESCO

Saini, Balwant Singh. 1962. "Housing in the hot and arid tropics", Ekistics, Vol. 13, pp. 172-176

Sargent, Frederick II. 1963. "Tropical neurasthenia: giant or windmill?", pp. 273-314 in Environmental Physiology and Psychology in Arid Conditions. Reviews of Research. Paris: UNESCO

Schanberg, Sydney H. 1970. "Pakistani capital", New York Times, April 10, 1970, p. 12

Schreider, Eugene. 1963. "Physiological anthropology and climatic variations", pp. 37-73 in Environmental Physiology and Psychology in Arid Conditions. Reviews of Research. Paris: UNESCO

Sethi, B. L. and Sharma, J. N. 1952. Field Crops. Kanpur: the authors

Sewell, Robert and Dikshit, Śankara Balakrishna. 1896. The Indian Calendar. London: Swan Sonnenschein and Co.

Shankar, Pandit Shyam. 1924. "The mystery of stereotyped customs in India", The Asiatic Review, n.s. Vol. 20, pp. 622-646

Sharma, H. K. 1964. Kanpur: a Study of an Industrial Location. Post-Graduate Diploma in Housing Thesis, School of Planning and Architecture, New Delhi

Singh, B. N. and Singh, C. M. 1960. Kanpur: a Study of Industrial Housing. Thesis, School of Town and Country Planning, New Delhi

Singh, Lekh Raj. 1956. "The Tharus: a study in human ecology", The National Geographical Journal of India, Vol. 2, pp. 153-166

Singh, Mahatma. 1967. "N. E. U. P.--a vast developing slum", Deccan Geographer, Vol. 5, pp. 98-103

Singh, Mohinder. 1947. The Depressed Classes. Bombay: Hind Kitabs

Singh, R. L. 1957. "Typical rural dwellings in the umland of Banaras (India)", National Geographical Journal of India, Vol. 3, pp. 51-64

Singh, Saint Nihal. 1913. "India's untouchables", The Contemporary Review, Vol. 103, pp. 376-385

Sperling, Jan Bodo. 1969. The Human Dimension of Technical Assistance. Ithaca: Cornell University Press

Srivastava, Danpat Rai. 1969. The World of Premchand. Bloomington: Indiana University Press

Subherwal, O. P. 1961. Problems of Slum Dwellers in Delhi. Thesis, School of Town and Country Planning, New Delhi

Subrahmanyam, K. and Majumdar, N. 1952. "A study of the effect of different wall and roof materials of buildings on indoor thermal conditions", Journal of Scientific and Industrial Research, Vol. 11, pp. 402-410

Taylor, Carl C., Ensminger, Douglas, Johnson, Helen W., and Joyce, Jean. 1965. India's Roots of Democracy. Bombay: Orient Longmans

Thoburn, W. C. 1946. "The comfort problem in northern India", Heating, Piping and Air Conditioning, Vol. 18, pp. 120-125

_____. 1954. "House construction and thermal comfort in the tropics", Journal of Scientific and Industrial Research, Vol. 13A, pp. 521-531, 575-582

Thornhill, Mark. 1899. Haunts and Hobbies of an Indian Official. London: J. Murray

Tromp, S. W. 1963. Medical Biometeorology. Amsterdam: Elsevier Publishing Co.

Trompf, Vanne. 1965. Village Settlement of Delhi and the Punjab. Thesis for the Degree of Master of Architecture, Melbourne University

Trumbull, Robert. 1957. As I See India. London: Cassell and Co.

Unni, K. R. and Patel, K. A. 1964. "Structural conditions of rural houses", School of Planning and Architecture Rural Housing Wing Newsletter (New Delhi), Vol. 4, No. 4, pp. 1-5

Uttar Pradesh. Department of Economics and Statistics. Monthly Bulletin of Statistics

van Wijk, W. E. 1938. "Hindu almanac", Asiatic Review, n.s. 34, pp. 282-288

Vreede-de Steurs, Cora. 1968. Parda: a Study of Muslim Women's Life in Northern India. New York: Humanities Press

Wilson, P. W. 1937. The Romance of the Calendar. New York: W. W. Norton

Wiser, Charlotte Viall. 1929. "A Hindu village home in North India", International Review of Missions, Vol. 18, pp. 370-380

_____. 1955. "The foods of an Indian village of North India", Annals of the Missouri Botanical Garden, Vol. 42, pp. 303-361

Wiser, William H. 1933. Social Institutions of a Hindu Village in North India. Ph. D. Dissertation, Cornell University

Yap, Tian Beng. 1956. "Day time corrected effective temperature inside buildings in Singapore", The Medical Journal of Malaya, Vol. 10, pp. 326-331

IV

ADAPTATIONS TO HEAT IN THE PRESENT: DIET

A. Heat Stress and Nutrition: Current State of Knowledge

Before describing the actual diet in North India as it relates to the thermal environment, it might be profitable to review the current weight of scientific knowledge with respect to the relationship of heat stress and nutrition. Unfortunately, however, the nutritional experts admit that the evidence in this area is far from clear even with respect to animal studies, and for man it is confusing in the extreme.

The Food and Agriculture Organization's Committee on Calorie Requirements has tentatively recommended that for every 10 C.° (18 F.°) departure from the reference mean annual temperature of 10° C. or 50° F. (equivalent, that is, to Boston, Mass. or Frankfurt, Germany), the individual's minimal caloric requirement should be adjusted by 5% (with more calories required for lower temperatures and fewer calories required for higher temperatures).[1] However, Quenouille and his colleagues have suggested an important further distinction that should be made on the basis of relative humidity. They conclude that, starting with a mean annual temperature of 70° F. and a mean annual relative humidity of 75%, 24-hour metabolic requirements for men change inversely with temperature at the rate of 4 calories for each 10 F.°, and change directly with humidity by 3 calories for each 1%. Thus, the maximum environmental effects occur in hot-dry and cold-wet climates, energy requirements being reduced in the former and increased in the latter. The basal metabolism of a man weighing 66 kg. and with a height of 175 cm. would be, according to this formula, 1638 calories in New York, but 1463 calories in the central Australian desert and 1865 calories in the Canadian subarctic. Thus, caloric requirements will vary little in areas where temperature and relative humidity are <u>both</u> either high or low, and this

---

[1] In the case of the middle Ganges area of India, with a mean annual temperature of about 78° F., this would amount to a reduction of about 8% in minimal caloric requirements, when compared with an individual of identical weight, age, etc. living in the temperate zone.

. . . opposite effect of high temperature and high humidity would explain why, in parts of the tropics, the metabolism of Europeans and North Americans has been found to show little change from that in temperate regions. (Quenouille et al. 1951, p. 15)

In India, one study of seasonal variations in basal metabolism rate seems to show an increase in the winter months of between 5 and 10% over the annual average, and a decrease in the hot-dry months of between 5 and 10% under the annual average, with the transitional and the monsoon seasons near the yearly average (Saha, Sita Devi and Rao 1963). Seasonal deviations in this study appeared to be almost twice as great among younger men as among older men. However, the study was based on weekly two-run tests for a full year on only five subjects, and it is admitted that successive BMR test runs can vary up to 6% as a result of emotional and other extraneous factors.

Lower voluntary food intakes have been frequently observed in hot-dry climates as compared with cool climates in equivalent groups of fit young men (Johnson and Kark 1947, p. 378). "Hot-weather anorexia" may account for part of this caloric reduction, and in practice it is interrelated in complex fashion with the infectious and deficiency diseases which are especially prevalent in tropical climates.

Of course, by far the most important variable that must be held constant in contrasting cool-climate and hot-climate calorie needs is that of energy expenditure. The "hobbling effect" of heavy Arctic clothing, for example, always results in a high energy expenditure and a requirement for additional calories (Ibid., p. 379). Tromp has surveyed the literature and states his conclusions with a deceptive air of finality:

> All animals, including man, require and take less food in hot than in cool climates. The reduction in appetite is related to positive heat balance. (Tromp 1963, p. 414)

Johnson and Sargent have in fact plotted an inverse relationship between air temperature and calories ingested (Johnson and Sargent 1958, p. 181). Kark and his colleagues have summarized the current state of knowledge:

> Our observations on calorie intake are consistent with, but not conclusive for, the idea that calorie requirements may be less in tropical than temperate regions. . . . To the best of our knowledge no systematic observation has been made on the energy expenditure for a given type of exertion in high, moderate and low temperatures. (Kark et al. 1947, pp. 35-36)

Fox echoes this conclusion in a homely fashion:

> . . . Parkes, when discussing the diet of troops in India some time before 1883, gives this advice: "Our best guide at present for the quantity of food to be taken in the tropics, is to apportion it to the amount of mechanical work done, as in temperate climates. In India, as elsewhere, it must be in balance with exercise." The reviewer of today has the benefit of an enormous amount of relevant data and yet he wonders whether we can really improve much on this advice. (Fox 1958, p. 173)

In one of the most recent contributions to this subject, Consolazio and Shapiro have documented a claim that for men working in very high temperatures in the sun, and thus making special demands on the body's thermo-regulatory system, the caloric demand may even be slightly increased as compared with identical activity at a moderate temperature (Consolazio and Shapiro 1964, p. 125).

With respect to the question of greater or lesser protein and vitamin requirements in a hot environment, the matter is equally confused. Kark's group have surveyed the large body of experimental literature, only to admit that

> We can give no support to the proponents of high vitamin intakes in the tropics when a healthy adult population is in question . . . . Neither can we support the proponents of a diminished protein intake in the tropics. (Kark et al. 1947, p. 35)

The conventional view has been that a relatively large protein intake is undesirable in the tropics because of the high specific dynamic action of protein (thus further burdening temperature-regulating mechanisms that are already under stress), and because it increases water requirements (Grande 1964, p. 112). It is still felt that a high protein diet should not be consumed where water is short, due to the extra water demands for excretion of increased waste nitrogenous products (Pitts, Consolazio and Johnson 1944, p. 507). But recent studies suggest that the increase in heat production from a very high protein diet is less than 5%, probably about equal to the difference in muscular activity between standing instead of a supine position (Edman 1964, p. 549). The study of Pitts, Consolazio and Johnson (1944) indicated that protein intake may vary widely from 75 to 150 grams daily without effect upon performance of intermittent work in the heat. Indeed, since pyrexia tends to stimulate tissue catabolism, and since there are losses of nitrogen in sweat which in some circumstances or in some individuals may not be compensated by a diminished urinary loss of nitrogen, Mitchell and Edman have concluded that

> Considering all evidence it may be concluded that protein requirements may be slightly increased in the tropics by some 5 to 10 grams daily. (Mitchell and Edman 1951, p. 94)[1]

Whether or not persons in a tropical climate will voluntarily select diets lower--or higher--in proteins than would be the case in a temperate climate is impossible to determine from available evidence. After all,

> It is difficult to dissociate diet selections based upon economic status and availability of food supplies from selections based upon physiological motivations. (*Ibid.*, p. 83)

The one mineral whose rapid excretion in the perspiration of unacclimatized individuals is well recognized, the the bodily depletion of which can rapidly lead to heat exhaustion, is salt. The NaCl loss

[1]This fact does not per se affect protein-thermal environmental relationships, but those concerned with nutritional problems in the tropics must keep in mind that the protein requirements of growing children are about 150% to 200% of those of adults, while at the same time the individuals who do manage to survive a childhood of protein deprivation probably develop some adaptation to a lower level of protein nutritive intake.

can reach as high as 3 or 4 grams per liter in the perspiration of the unacclimatized man, and with profuse sweating (up to 10 or 12 liters per day under exceedingly hot and dry conditions), an absolute maximum salt loss of some 30 to 40 grams per day is theoretically possible, although in actual experience it is more likely to be about 15 to 17 grams (Chakravanti and Tyagi 1938, p. 795; Mitchell and Edman 1951, p. 93). Hence, salt tablets have long been recommended as dietary supplements for newcomers to the tropics, since the normal daily salt intake in cool climates is less than 5 grams per day and the body does not automatically respond to salt deficiency. However, it is becoming recognized that the sweat glands, as a part of the process of heat acclimatization, become much more efficient in conserving nutrients--so much so, in fact, according to Fox, that the salt loss in perspiration of acclimatized men with a low salt intake may reach a low extreme of 0.1 grams per liter (Fox 1958, p. 176).[1] In India, with a high dietary salt intake of at least 15 grams per day for active workers, the salt concentration in sweat averages only 0.25 grams per liter (Malhotra 1966, p. 350). Indian Army personnel receive 19 grams of salt daily, and this figure is doubled in the hot summer months (Malhotra 1964, p. 97).

As with protein needs, there are more questions than answers relating to vitamin requirements in a hot tropical environment. Certain claims that have been made for increased requirements for ascorbic acid or vitamin C in a hot environment are not presently accepted (Mitchell and Edman 1951, p. 79). Hardly anyone would disagree that

> The ever-present vitamin deficiencies in the tropics must stem from undernourishment and parasitic and microbial infestations rather than from high temperature, hot winds, and high humidity. (Edman 1964, p. 545)

(To this bleak repertoire of tropical disadvantages should be added, if some authorities are to be believed, a measurably inferior quality in

---

[1]Just conceivably, this kind of evidence can justify Ladell's recent conclusion that "Salt balance may be maintained with a daily salt intake of less than 17 meq [1 gm.], not only under temperate conditions, but even by a heavily sweating man provided he is properly adapted" (Ladell 1965, p. 248). But the statement seems extreme, even though it has been demonstrated that some tropical populations manage to cope with their climate on only 4 or 5 grams of sodium chloride a day (Epperlein 1964, p. 246).

the vitamin and mineral content of meats and vegetable products in the tropics, resulting from the poorer soils of these regions. The name of C. A. Mills (1942) is particularly associated with this argument.)

There is evidence that profuse sweating does produce measurable losses of calcium, potassium, fat, protein and iron (the last two resulting from shedding of keratinized epithelium and cell desquamation). But this fact must be balanced with the awareness that (1) in normal healthy individuals the process of heat acclimatization produces an increased efficiency of the sweat glands in conserving most body nutrients, and (2) most nutrient losses from perspiration are relatively small. In the case of calcium, hot environments produce increased fecal losses (Mitchell and Edman 1951, p. 94). And, although this is not a direct result of the thermal environment per se, the diarrhea that frequently--and for newcomers almost typically--accompanies tropical residence results in large losses of dietary nutrients.

Once again, however, we are faced with the medically intractable problem of individual variation, for the differences in nutrient loss from the skin surface can vary enormously from one individual to another, and even in the same individual from time to time (Fox 1958, p. 177). And in the case of tropical communities whose dietary intake is already on the border-line of adequacy (a description that fits most North Indians), some of the sweat and dermal losses of nutrients, small as they are, may approach a critical significance. The first and main physical impact of heat stress in the tropics is on the skin, adding prickly heat and other dermal disorders to the changes in skin texture such as "dry" skin, "mosaic" skin, and "crackled" skin so frequently seen in tropical communities living on inadequate diets. In the last analysis, however,

> Our knowledge of what these changes mean in terms of disturbed functioning of the skin as an organ and in its role in the metabolism of the body as a whole is . . . exceedingly meagre. (Fox 1958, p. 177)

Not only is scientific knowledge of the relationship between thermal environment and nutritional requirements imprecise, but even the questions of minimal and optimal caloric intake are uncertain. The Nutrition Advisory Committee of the Indian Council of Medical Research has set the daily energy requirements of the "reference man" (25 years old, weighing 55 kg.) at 2780 calories, and those of the "reference woman" (25 years old, weight 45 kg.) at 2080 calories, or a combined average of 2430 calories (Sukhatme 1965, p. 36). These totals are based on 8 hours a day of "light industrial work" at the level of 2.5 cal/kg/hr. If 8 hours of sedentary activity at the rate of 1.7 cal/kg/hr is assumed instead, the average caloric requirement falls to 2110 calories (2430 for men and 1790 for women), and if heavy work at the rate of 5 cal/kg/hr is assumed, the average rises to 3430 calories (3880 for men and 2980 for women).[1] But who is to say whether a 2000-calorie, or even a 2400-calorie, national average diet is adequate or inadequate in North India when, as McArthur points out, there have been no energy expenditure studies on farmers in India,[2] and very few on farmers elsewhere in the world. Taking mankind as a whole, communities have been observed which seem to be able to survive on a stable basis on as few as 1350 calories daily (McArthur 1964, p. 395). But there are no answers as to whether an "inadequate" caloric intake is correlated with lower energy expenditure on work, on leisure, or on both, or whether working hours are curtailed by such undernutrient diets, etc. (Ibid., p. 396).

B. Food Concepts and Seasonal Diets

Both in Ayurvedic medicine and in the beliefs and attitudes of North Indians today, diet is assigned a much greater determining role in health and sickness than is the case in modern Europe or America, except perhaps among the fringe groups of macrobiotics enthusiasts and other so-called "food faddists". To the average Indian villager today the notion that microscopic pathogens are the essential causal agents of disease is quaint and meaningless, and the North Indian equivalent of an American's statement that "I must have picked up some bug", in explaining an obscure indisposition, would probably be something like "The water there didn't agree with me", or "I ate 'cold' food in the evening (or 'hot' food at noon)", or the like.

[1]Downward adjustments in energy requirements with age are also made by the NAC: a 3% decrease applicable to the reference man for every 10 years after 25 up to 45, and 7.5% for every decade from age 45 to 65 (Sukhatme 1965, p. 20).

[2]The average daily energy requirement for Indian peasants or rural workers engaged in their normal activities was once estimated by Aykroyd at 2560 calories (Patwardhan 1952, p. 145).

From its beginning Ayurvedic medicine attached great importance to diet both as a preventive and as a curative and the literature of Ayurveda is an immense repository of prescriptions and avoidances to accord with the season of the year, the humoral type, and the specific imbalance that may be involved. Probably the elaborate and complex phytotherapy contained in the Caraka Saṃhitā, the Bhaishajyaratnavalī, the Pathyāpathyam, and numerous other Ayurvedic works was never known in more than general terms to the majority of people or ever followed very scrupulously by them in practice. Caraka and his colleagues did not conduct dietary surveys for our edification,[1] but other historical sources suggest that the overall features of the average diet have not changed much in the past twenty centuries, except in becoming increasingly more impoverished. Maize, potatoes and tomatoes are about the only important new foodstuffs that have been added to the North Indian diet since Caraka's time, while the average person's consumption of meat and dairy products has declined during the intervening centuries.

Most of my informants in the Varanasi region were not familiar with the subtler details of the classification of qualities and properties of substances (dravyaguṇa) that has been made in the Ayurvedic system. Only the vaidyas are expected to be experts at this. Nevertheless, they hold strong beliefs that foods vary greatly in their possession of particular qualities and properties. Some foods are "hot" (heat-producing), while others are neutral and still others are "cold" (cold-producing).[2] Some foods are considered "light" (easily digested) and others "heavy" (hard to digest). Villagers may also credit different foodstuffs with having certain other properties: constipating, laxative, "blood-purifying", "strength-building", aphrodisiac, Vata-, Pitta-, or Kapha-reducing or increasing, etc. Their beliefs tend to be somewhat simplified or even distorted versions of the classical Ayurvedic tradition (Opler 1963).

---

[1]Unfortunately, no early Indic work on cookery has survived to the present time (Edwardes 1969, p. 103). However, an excellent reconstruction of the diet of the ancient period and its evolution has been made by Om Prakash (1961), based on incidental references scattered through thousands of Sanskrit and Buddhist sources.

[2]Bhojpuri-speaking villagers in eastern U. P. use the words tāp ("hot, heat") or tāpgun (Bhoj. gun = Hind. guṇa, "quality") and sīt ("cold") or sītgun to refer to these qualities (Shukla 1970).

Much of the typical North Indian's attitude toward summer diet is based upon the assumption that his digestion at this time of the year is no longer fierce and strong as it was in winter, but rather is so weakened and feeble that he must avoid bhārī ("heavy" or hard-to-digest) foods, at least during the hot hours of the day. Sometimes this leads to the custom of eating as much good food and spices as possible in the winter lest the strength fail in summer, as Hendley found in Jaipur (Hendley 1895, p. 67). Certainly the preferred summer foods in North India are those that are halkā: "light" or easy-to-digest.[1]

When villagers speak of a food being "light" (halkā), they generally refer to a quality of digestibility, deriving clearly from Ayurvedic belief (see Appendix A). The boiled pulse preparation (dāl) which is the principal source of protein in North Indian diets is generally cooked with some sour fruit in it. While this serves to modify and improve the otherwise probably monotonous flavor (and may add ascorbic acid), the usual explanation is that it makes the boiled pulse "lighter". This is in fact an old Ayurvedic recommendation (Kaviratna 1890-1901, p. 376n), as is the idea that capātīs are "lighter" if they are cooked in such a way that heat is applied on every side.

Incidentally, Indian villagers, or at least those whose staple cereal is wheat, are acutely sensitive to what might seem to the outsider to be imperceptible differences in texture and flavor of capātīs, which are affected by the type of grain used, the amount of kneading, the procedure of cooking, etc. This is why the introduction of new high-yield wheat strains, such as the recently successful dwarf Mexican varieties, must overcome considerable established taste preferences and objections rooted in the existing culture, as Marriott has reported with his usual felicity:

> The grain is indeed big--so big and tough that the women cannot grind it well in the old stone flour mills. Dough made from the new flour is difficult to knead and hard to bake into good bread. The new bread, which is

[1]The physiologist Burridge, teaching in universities in U. P., customarily included in his examination a question about the effects of hot weather on the student. His survey of several hundred responses showed that the chief complaint was one of indigestion (Burridge 1944, p. 33).

all a poor farmer would have to eat, does not taste like the good old bread: it is flat and uninteresting (the explanation being in part, of course, that it does not contain that potpourri of barley, peas, gram and mustard seeds that "wheat" contained in the old days). Next, look at the cows and bullocks! They do not like to eat the straw of the new wheat; they will die of hunger if we grow it. The straw is worthless, too, for thatching roofs. It does not even make a good fire to warm our hands in winter. (Marriott 1952, p. 266)

During recent years of food shortage in India and large imports of American wheat, it was said that American white wheat was too glutinous to make good capātīs, and American red wheat was too hard. The two had to be combined for best results, and even so American wheat sold in the urban Indian marketplace at only three-fourths the price of good Indian Panjab wheat.[1] Even while the U. P. landowners are being converted to the improved hybrid varieties of wheat they continue to reserve some plots for the old-fashioned wheats preferred for making capātīs for their own home use.

The following is a small sample list of foods and food-pairs considered "hot" and "cold", either in themselves, or relative to each other, in the village of Madhopur, near Varanasi:

---

[1] Now, however, such sources as the Rockefeller Foundation, which has been heavily involved in the development of improved cereal strains in India, are visualizing a much greater future demand in Indian cities for baked loaf breads, which require wheat with a higher gluten content than the wheat used for capātīs. The main and most important nutritional emphasis has been on the evolving of wheat strains with a higher protein content, and this has been successful to the extent of an increase from 9-10% in traditional Indian wheats to 16-17% in the improved varieties (Streeter 1969, p. 20). It was announced in September 1970 that nine modern bakeries have been set up in the public sector in important cities, to have a planned production of 10 million loaves per month of vitamin-, mineral-, and lysine-fortified bread (Mathrani 1970, p. 2).

"Hot" or heat-producing foods	"Cold" or cold-producing foods
Raw grains	Parched grains
Wheat	Rice
*Sorghum[1]	Barley
Dried peas	Green peas
Potato	Taro (aravī)
Bengal gram	Horsebean
Lentils	Kidney beans
Eggplant	Tomato
Jackfruit	*Wood-apple (bēl)
Coconut	*Lime or lemon
Ripe mango	*Baked green mango
Canteloupe	Watermelon
Mustard oil	Ghee
Dried ginger	Green ginger
Cloves	Turmeric
*Meat	*Curds
*Eggs	Sugar
*Peanuts	Bananas
Green pepper	Spinach

The "hot" or "cold" qualities of foodstuffs are typically neutralized or even reversed by processing or ripening. Thus, by being parched in hot sand the raw cereals and pulses become neutral or relatively "cold".

[1]Items marked with an asterisk are considered "very hot" or "very cold".

A striking example of a food considered extremely "hot" is "elephant yam" (Amorphophallus campanulatum, locally called sūran, ōl, or zamīn kand), a tuber of huge size which has an interesting association with the festival of Divali . On Divali (symbolically marking the beginning of winter) everyone is traditionally supposed to eat a dish of sūran--"those who do not will be reborn as pigs" (Planalp 1956, p. 328). One official in Patna described vividly to me how his father, after eating this tuber, would be able to sit on cold winter evenings without a shirt. Nībū (lime) juice and salt must be mixed with sūran to make it palatable, since otherwise it has a peculiar biting or irritating quality.

It should be noted that there are differences of opinion from region to region and indeed from one individual to another in the same village with respect to the "hotness" or "coldness" of many specific foodstuffs. For example, Leela Dube found it necessary to query 20 or 30 different women in a village in northwestern U. P. as to the qualities of each particular item of diet before she could be reasonably sure of a consensus as to whether it is "hot" or "cold"--and in some cases opinion was rather evenly divided (Dube 1956).[1] In fact, foodstuffs are likely to be referred to as "hot" or "cold" relative to each other. Compared to a "very cold" food, a "neutral" food may be described as "hot". As an example of regional variation, I found that in Patna sorghum, jackfruit and peanuts are not widely regarded as "hot" foods as they most definitely are in Varanasi, only 125 miles distant. Many foods considered "hot" in North India are "cold" in South India, and vice versa (Taylor 1968, p. 158).

North Indians of course claim to prefer "hot" foods in winter and "cold" foods in summer, and in most respects their actual seasonal consumption of foods appears to accord with their ideas. Thus, people do eat relatively more meat and eggs in winter than in summer, and such foods as peanuts and thick flat cakes made of sorghum flour are cold-

---

[1]Compare, for example, Jelliffe (1957), Khare (1961), Khosla (1963), Mahadevan (1961), and C. Wiser (1955) for other local variations in the "hot" and "cold" food concepts. It should also be noted that many villagers distinguish between "good hot" and "bad hot" foods. The latter are believed to cause increased sexual desires, and eggs are most often mentioned in this connection. But some people think this is true of all "hot" foods.

season favorites in eastern U. P. Eggs are cheaper in price in summer than in winter, even though they are less plentiful in supply at this time.[1] In Varanasi, street vendors of roasted peanuts abound in every bazaar during the winter, but are nowhere to be found from April until September. Sorghum bread is disdained or considered a low-prestige food at other times of the year, but even the upper castes and wealthier farmers use and relish it in cold weather. The variant of unleavened bread that is prepared in the winter but seldom at other times of the year is <u>liṭṭī</u>, a heavy thick cake of any of various cereal flours, often stuffed with pea, gram, or some other pulse. Behura remarks, in reference to these stuffed "breads", that

> During brisk agricultural operations a peasant craves for such a dish. (Behura 1962, p. 121)

Some spices, such as dried ginger (<u>sõṭh</u>) are favored in winter, others (e.g., mint and coriander) in summer, and others, such as <u>ajavāyan</u> (<u>Carum capticum</u>), during the rainy season.

> In the severity of cold weather protection is obtained from its effects by the use of sonth. (Hamdard 1959, Vol. I, p. 197)[2]

In connection with North Indian ideas of the seasonal appropriateness of various foods, one must certainly mention the saying attributed to a long-vanished folk-poet, Ghagh, and his wife Bhaddari. Most of the cycle of poems accumulated in their names crystallize folk-ideas relating to the agricultural cycle and activities. The first of two famous quatrains refers to foods which should be eaten, and the second to food and behavior which should be avoided, in different months (see the list of Hindu lunar months on p. xi). No two persons seem to

[1]This statement is based on the word of informants, since seasonal egg production statistics in India are not available to me. The annual egg production in U. P. was only 56.8 million eggs in 1956 (National Council of Applied Economic Research 1965, p. 48).

[2]Because of other qualities (digestive aid, relief of flatulence and pain, etc.), <u>sõṭh</u> also is the principal ingredient of a special food, called <u>sõṭhaurā</u>, which is given to women after childbirth (Planalp 1956, p. 396).

agree on the exact wording of these poems, but according to one published Bhojpuri version they are as follows:[1]

Sāvan harre, Bhādõ cīt. Kvār mās gur khaya/u mīt.
Kātik mūlī, Agahan tēl. Pūs mẽ karai dūdh se mēl.
Māgh mās ghī khicarī khāy. Phāgun uṭhi ke prāt nahāy.
Jēṭh mās jē din mã̄ sōvai. Ōkar jar Āsārh mẽ rōvai.

"In Savan [eat] harre,[2] in Bhadon citrak.[3] Eat guṛ in Kuar, O friend!
Radish in Kartik, oil in Agahan. Make friends with milk in Pus.
In Magh eat ghee and khicaṛī.[4] Take an early morning bath in Phagun.
In Jeth sleep in the daytime. [Whoever does all these], his fever weeps in Asarh."[5]

Caitē guṛē, Baishākhe tēl. Jēṭh mẽ panth, Ashāṛhe bēl.
Sāvan sāg au Bhādo dahī. Kvār dūdh aur Kātik mahī.
Agahan jīrā, Pūs dhanā. Māghe mishrī, Phāgun canā.
Ī bārah sō bacē jōbhāī. Tā ghar baidhy na sapnē āī.

"Guṛ in Cait, oil in Baisakh. Traveling in Jeth, bēl in Asarh.
In Savan spinach, in Bhadon dahī. In Kuar milk and Kartik buttermilk.
In Agahan cuminseed, in Pus paddy. In Magh sugar-candy, in Phagun canā (Bengal gram).
O brother, whoever preserves himself from these twelve, even in his dreams the vaidya (doctor) does not visit his house."

---

[1] These verses are quoted from Ghāgh aur Bhaḍḍarī, published by Shri Ganga Pustak Mandir, Patna, Bihar, n.d., p. 74. Variant spellings of the same word in different lines may reflect either normal poetic license or else faithfully reproduced typographical errors.

[2] Harre = harrā, a large myrobalan.

[3] Citrak = cirāyatā, a gentian (Gentiana cherayta, according to Bhargava's dictionary).

[4] Khicaṛī is pulses and rice boiled together.

[5] I.e., he will not become ill in Asarh--a typical Hindi usage, personifying a quality or a condition, such as fever.

The folk ideas about "hot" and "cold" foods, even though ill-defined and inconsistent, are so widespread and influential in much of India that a preliminary investigation of their nutritional and biochemical correlates was carried out by the Nutrition Research Laboratories of the Indian Council of Medical Research a few years ago (see its <u>Annual Report 1961-62</u>). Two subjects were fed diets incorporating mainly foods considered "hot" (according to folk belief in the Telengana region near Hyderabad) for ten days, while two others were fed diets consisting mainly of "cold" foods. In all other respects the diets were held constant (in total calories, fat content, protein value, etc.). Measurements of nitrogen, calcium, phosphorus, and sulphur excretion and balances, as well as other analyses, were made after ten days. The diets of the four subjects were then reversed and after ten more days the same measurements were again taken. Results showed that the nitrogen retention in the "cold" diet period was considerably greater than in the "hot" diet period, the pH of the urine in the "hot" diet period was significantly lower than in the "cold" diet period, and the excretion of sulphur in urine was higher in the diet based on "hot" foods. These findings have not been further explained, but may be compared with the general consensus of folk beliefs that an excess of "hot" foods produces

> . . . a burning sensation in micturition, mild burning sensation in the eyes, and a "sense of heat" all over the body. (Indian Council of Medical Research. Nutrition Research Laboratories. <u>Annual Report 1961-62</u>, p. 41)

While many of the staple articles of diet in North India are available year-round at about the same price, at least in cities, most of the fresh fruits and vegetables do have seasons of abundance and of scarcity or absence, which strictly define their appearance or non-appearance in the diets of most people. It is probably significant that many of the fruits and vegetables considered "cold" in their effect are in fact available in the greatest quantity and at lowest prices during the hot weather--limes, <u>bēl</u> or wood-apple, green mangoes, watermelon, cucumber, tomatoes, etc. And much the same is true of "hot" foods in the winter. Dr. J. K. Sen Gupta, Medical Officer of the U. P. Applied Nutrition, has observed that villagers generally regard their staple cereal, whether rice, millet, maize, or wheat, as neither "hot" nor "cold", but as neutral (Sen Gupta 1966).[1] There appear to be relatively few instances, in fact, of incompatibility between the "heat"-producing or "cold"-producing quality of a foodstuff in popular belief and its season of plenty. One of the exceptions (in Varanasi) is jackfruit, which is most plentiful in April but is considered a "hot" food. In the case of mangoes, which begin to ripen at the end of May, many people refrain from eating ripe mangoes before the appearance of the monsoon, since they are "hot" and might contribute too much internal heat to that already present in the external environment.

> It is always said that you get boils if you eat too many mangoes . . . (King 1884, p. 272)

But ripe mangoes are popularly considered very nutritious, especially in making boood. Hence, those who wish to eat them will soak them a few hours or overnight before eating, or after eating the ripe mangoes will drink some cold water to counteract the effec : heat. According to one informant, a Bihari girl attending college in Varanasi, "Before the rains mangoes are very 'hot' for the system but in the month of Sāvan when the monsoons start they become amrit phal (fruit like nectar)."

---

[1]In Rajasthan, Carstairs has described an interesting pattern of apparent association of the "thermal" classification of foods with the idea that semen is "the source of a man's strength and of his subjective sense of well-being" (Carstairs 1955, p. 124). Here the "cold" foods (which, in many cases, are also white in color), such as dairy products, wheat flour, refined sugar, some fruits, and some of the milder spices, are considered conducive to the increase of ser n, while the cheaper and heavier cereals, unrefined sugar, vegetable oil, strong spices, some of the commonest fruits--and above all meat, eggs, and alcohol--are regarded as detrimental to semen production. Needless to say, differential access to the two types of food is also strongly caste-defined on economic grounds. I have not found this series of conceptual and socio-economic associations to be so clearly adumbrated or highly correlated in eastern U. P. culture as is alleged by Carstairs in Rajasthan, but some shadows or echoes of the pattern may 'e recognizable throughout North India.

Soaking ripe mangoes in water is an example of a characteristic feature of traditional Hindu ritual and custom: the provision of some short-cut or some loophole in a rule or precept to allow its circumvention whenever that rule or custom becomes too inconvenient, impractical or otherwise contrary to human nature. Thus, a North Indian who enjoys eating jackfruit in summer when it is plentiful but who knows that it is a "hot" food will simply have it processed in such a way that the "heat" is neutralized, or he eats it in the evening when temperatures are somewhat lower. In fact, it is almost always accompanied by salt, which is considered a "cold" food and without which jackfruit is thought to cause stomach ache.

North Indians emphasize the need to increase water intake in summer. However, they look upon the consumption of liquids more in terms of a "cooling" effect than a physiologically thirst-assuaging matter. Thus, sugar is usually included in drinks because it is "cold" in effect. The summer drink considered most effective as a refrigerant is _ām kā pannā_ or mango _pannā_ (from Skt. _pānasa_), made from the pulp of roasted unripe mangoes.[1] To prepare this drink, mangoes of sufficient size and good quality (the skin should not be broken) are roasted in coals until they are soft and the outer skin almost burned. They may also be boiled, but most people prefer the roasted variety. The skin and seed are then removed and the pulp is soaked for more than an hour, or overnight, in cold water in an earthen pot. It might be noted that all these features--the unripe

[1]Nadkarni notes that "A confection made of the baked pulp of the unripe fruit mixed with sugar is taken internally in times of plague or cholera, and also rubbed over the body as a prophylactic" (Nadkarni 1954, Vol. I, p. 767). It is not without ample reason that the _Mangifera indica_ has so long been exalted in India as the "king of fruit". Nadkarni's treatise devotes no fewer than three pages to listing the uses in folk and Ayurvedic medicine of the mango in one or another form, including ripe fruit, unripe fruit, juice, sun-dried juice, rind, pulp, kernel juice, kernel flour, bark juice, powdered bark, infusion of bark, dried leaves, calcined leaves, decoction of leaves, ashes of leaves, smoke of burning leaves, dried flowers, flower tea, gum of the tree, gum-resin of the bark, and so forth (_Ibid._, pp. 768ff). Each of these products is credited with distinct qualities and has its special therapeutic applications.

mango, the process of roasting, the cold water, the clay jar, and the salt--have a "cold" effect, and in combination they produce the "extremely cold" quality of mango pannā, in terms of the popular belief system.

Some type of salt[1] and parched safēd jīrā (caraway) may be ground together and added to the pannā also, and some people like sugar, mint, etc. Some individuals drink pannā regularly, while for poor people it is more likely to be only a festive drink and a specific treatment for suspected heatstroke (see Chapter V). In large cities the pannā vendor appears about the first of April, his cart readily recognizable by the large globular clay pot covered with a wet cloth, festooned with mango leaves and a wreath of five green mangoes hanging about its neck.

Another popular pannā is that made from the pulp of tamarind pods, soaked in water and mixed with sugar. In areas where a guṛ or crude sugar is processed from the palmyra or "toddy" palm tree (tāṛ), a

---

[1]A favorite form of salt in North India is kālā namak or "black salt", the exact definition of which varies so much in the literature. Mrs. Wiser describes it as a fusion of sodium chloride and sodium carbonate (C. Wiser 1955, p. 319). Bhargava's dictionary simply calls it "a kind of rock salt which is of a deep red color", while Bhandari has it as a mixture of salt and dried ā̃valā (Phyllanthus emblica, the emblic myrobalan), heated and powdered (Bhandari 1951, p. 1008). Kaviratna, finally, gives us the following definition: "A dark colored salt said to be made by dissolving common salt in a solution of crude soda and evaporating it; this salt contains chloride of sodium, sulphate of soda, caustic soda and a little sulphate of sodium, but no carbonate of soda" (Kaviratna 1890-1901, p. 382n). The Salt Industry in India gives detailed chemical analyses of 74 named varieties of salts, but fails to allude anywhere to kālā namak (Aggarwal 1956, pp. 353ff). Might the different definitions be partly due to regional variations? At any rate, kālā namak has the major virtue for Hindus of being permitted during fasts and on ritual occasions in which ordinary or sea salt is forbidden. According to Behura, rock salt is much less used in India since 1947, because the Salt Range is in Pakistan (Behura 1962, p. 133). A third major type of salt, used by poorer people and considered inferior to other salts, is earth salt.

favorite cooling drink is made from this gur dissolved in water with nībū (lime or lemon) juice (Dwarkanath 1963). Probably the most heavily consumed of all summer drinks are those having a fruit or syrup base, the kind generally referred to locally as sharbat.[1] They include an immense variety of actual preparations. Thus, to the masses of poor landless rural laborers the word sharbat means simply the drink made from jaggery or gur of sugar cane dissolved in water, which in fact constitutes a large part of their diet during February and March when grain supplies are low or exhausted. To the more literate, the urban middle and upper class segments of the population, however, sharbat means rather a refreshing ade or squash made from a fruit such as wood-apple (bēl), oranges, watermelon, phālsā, etc. In the form of nībū pānī it is simply lemonade, made from the small perishable "Key lime" (nībū: Citrus bergamia), so widely grown in the countryside.[2] Of the bēl (Aegle marmelos), Chopra has said:

> No drug has been longer and better known nor more appreciated by the inhabitants of India than the bael fruit. (Chopra 1933, p. 269)

---

[1]The English word "sherbet" is derived from Arabic as is the Hindustani word, but their meanings have diverged considerably. "Pannā" may be subsumed under the category of "sharbat" also. The novelist Ahmed Ali, in his Twilight in Delhi, describes the roasting of unripe mangoes to make a "green mango sherbet" (Ali 1966, p. 91).

[2]It is interesting to compare Indian drink preferences in the summer season with the results of a scientific study in Israel reported by Sohar, Kalz and Adar (1964). In that study, a wide selection of drinks, including plain water, milk, beer, carbonated drinks, pure citrus juice, and cold sweetened fruit-flavored drinks were made available ad libitum to soldiers marching 17 miles per day with 35-lb. packs in the hottest month. Preferences showed wide individual variation when the drinks could be consumed at leisure, or with meals, or in small quantities. But so far as their suitability for consumption on the march (with a view to rapid replacement of large amounts of fluid) is concerned, the best drink by far was found to be cold water tasting of sweetened citrus fruit. Pure citrus juice often caused "heart burn", milk caused diarrhea, beer produced drunkenness in short order, and carbonated drinks were almost the least favored because they gave a feeling of fullness, thus preventing sufficient liquid intake.

Many therapeutic properties, to be described in the next chapter, are ascribed to the wood-apple. Phālsā (Grewia asiatica) is a small, tart fruit whose cooling properties and usefulness in hot weather were praised by the early Sanskrit writers (Nadkarni 1954, Vol. I, p. 593).

Most poor people in towns and cities--and villagers too when they flock to the religious fairs or melās--are more apt to patronize street vendors who display an assortment of bottled syrups of brilliant colors but uncertain composition, and who charge only the equivalent of a cent or two for a glass of cold or iced syrup and water to drink. The flavors include many uniquely Indian distillations from such fragrant plants as sandalwood, khas, gulāb (rose),[1] kēvaṛā (pandanus), etc. There are bottled syrups and squashes of good quality, prepared by reputable firms, and there are others whose nature and purity may be questionable.

The sharbats and sweet syrups merge into another category of summer drinks which not only refresh and reduce thirst, but also are considered to have more or less tonic effects. They include such favorites as jal jirā (literally, "cuminseed water", but actually a mixture of powdered substances including lemon and mint in a rock salt base). Among the summertime drinks are also such popularly advertised and well-known (in cities, at least) proprietary names as Amrit Dhara and Roohafza (rūhafzā), bottled syrups prepared from various herbs. An inspection of the Roohafza label, for example, shows that it is described as "a remedy for sun-stroke" (see Figure 5). One recent American observer has likened the smell of Roohafza to that of the khaskhas screens: "a pleasing heather-like fragrance" (Lukas 1965). Other summer drinks in the Varanasi region are prepared from various plants: cirāyatā, ghīkũvār, tūtamalangā, gadahapūranā, isabgōl, etc.,[2]

---

[1]Mrs. Roberts remarked in 1837 that "rose water" (gulābī pānī) is "consumed in vast quantities in every native house" in such North Indian cities as Benares (Roberts 1837, Vol. I, p. 188). Although still popular, it is by no means such an overwhelming favorite today.

[2]Cirāyatā is gentian, ghīkũvār is Indian aloe, isabgōl (or īsaphgōl, or isphagul, etc.) is a Plantago or fleawort species, and gadahapūranā is identified by Dey as Boerhaavia diffusa, a troublesome weed (hog-weed?) of the natural order Nyctagineae (Dey 1896, p. 48). I am presently unable to identify tūtamalangā.

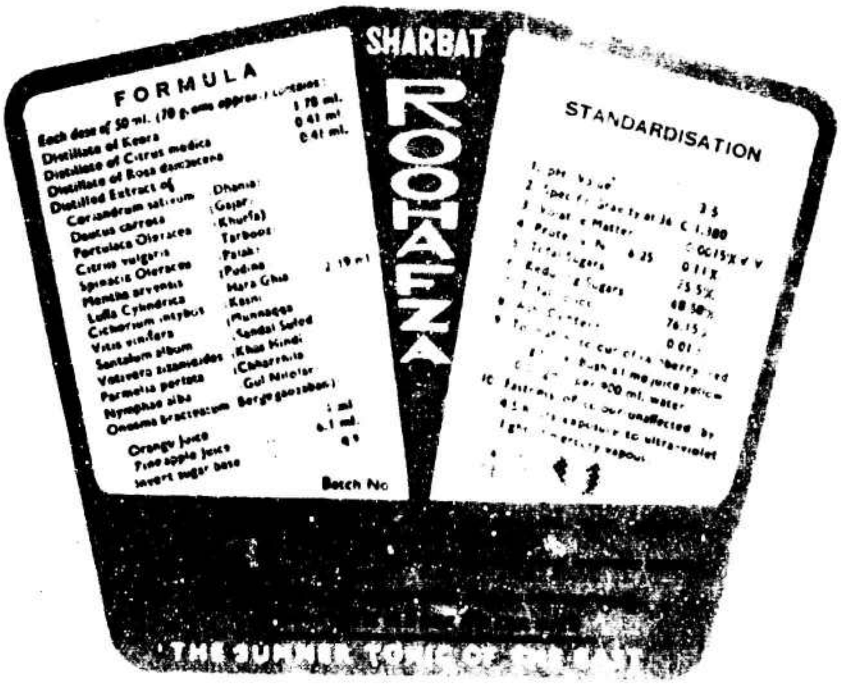

Figure 5. Roohafza Label

and some are apparently used largely or wholly by men for medicinal effects to be described in the next chapter. So far as cirāyatā is concerned:

> As a remedy against the languor and debility which affect many persons in summer and autumn, nothing is equal to the cold infusion of this plant. (Balfour 1885, Vol. I, p. 41)

Among those persons who are able to afford the relatively costly dairy products, a very popular summer drink is made from curds (dahī) churned with water, to which may be added any or all of the following, according to caste: ice, sugar, salt, and pepper. This drink is generally known as lassī in western U. P. and is so listed in restaurant menus throughout North India, but in the villages of eastern U. P. it is called maṭṭhā (Hind.) or māṭhā (Bhoj.). It is most frequently used as a morning or breakfast drink. But for the great majority of poor villagers maṭṭhā is only a mirage. Since they don't have it and can't afford it, they use guṛ sharbat--water flavored with unrefined jaggery--instead. Or else,

> It is a common practice in ordinary Indian houses to dilute the curds into drinks so that a small quantity of this valuable food may be partaken by a very large number. (Indian Council of Medical Research, 1951, p. 16)

Another special hot-weather libation is ṭhanḍāī, whose very name implies a cooling quality (ṭhanḍā = cold). Villagers near Lucknow say the body feels cooler after drinking it (Hasan 1961, p. 196). In its classic form ṭhanḍāī is made from almonds, cucumber seeds, watermelon seeds, muskmelon seeds, rose petals and anise--and a dozen other rare and expensive optional ingredients could be listed, including poppy seeds, saffron, cardamom, musk, pistachio nuts, licorice, pomegranate juice, and senna leaves (Chopra and Chopra 1965, p. 168). However, the average person can afford to drink only a simplified and less expensive version of ṭhanḍāī, using water rather than milk, guṛ instead of sugar, and omitting or reducing the costly ingredients in favor of black pepper, anise, cloves, etc. The various solid constituents are soaked, ground and then strained, after which the sugar and milk or water are added. Actually, ṭhanḍāī tends to be drunk mostly by men (a man's strength is required to stone-grind all the ingredients, one informant disingenuously explained!) and it tends to be associated with religious worship. This is because in actual practice thandāī is usually laced with a potent infusion of bhāg (derived from Cannabis sativa or marijuana,[1] a plant sacred to Shiva), and in this form it is greatly favored by the Shaivite sādhus (ascetics or "holy men") and other worshipers of Shiva.

Actually, while hemp has positive sacred associations for Hindus, religious opprobrium attaches to alcoholic liquor and other drugs, which are forbidden to Muslims and to pious Hindus, especially to sadhus and bhagats. Hasan's careful study in a Lucknow village revealed that, while 87% of the adult men used hemp at least on rare occasions, only 5% were dependent on the drug (and even these could carry on normal work so long as they could obtain regular doses). No bad effects were apparent from its use, and there was no tendency to increase the dose (Hasan 1961, p. 199). Despite the religious prejudice against alcoholic liquors, Hasan found in the same village that 73% of Hindu men are willing at least on rare occasions to use dārū (whiskey or brandy) or a distilled moonshine called tharrā or deshī sharāb ("country liquor"), and 68% drink toddy (tāṛī), although there are only a few men who consume any of these with daily regularity. Even 50% are willing to drink denatured spirit (which, in addition to the harmful ethyl, amyl, propyl and butyl alcohols which make "country

---

[1]There has been considerable confusion in the literature as to the exact nature of various hemp-derived products (notably, gāja, bhāg, and caras) used in India. However, the descriptions provided by Dastur (195-, pp. 66-7) and especially by Chopra and Chopra (1965, pp. 165-8) appear to be definitive, and also explain regional variations in terminology. Each of the hemp derivatives has a variety of medicinal uses in village India (appetizer, aphrodisiac, anesthetic, stimulant anti-prurient, etc.). According to the authorities cited above, bhāg consists of the dried leaves (often with the capsules or flowering shoots) of both the male and the female plants. These leaves are pressed and stored in earthenware vessels. Bhāg is drunk as a liquid, taken as a pellet, or mixed in sweetmeats. As a liquid, it is most simply prepared by pounding the bhāg with a little black pepper and mixing it with sugar and water.

liquor" so potent, includes certain toxic additives: 1/4% methyl alcohol, 1/20% pyridine, and 2% petrol).[1] Increased use of the potentially lethal denatured spirit has resulted from government prosecution of the illicit distillation, although Hasan found no serious effects in his village, since only very small amounts were consumed. Even so, he noted that a few lower caste men have come to enjoy the taste of the ispirit, as it is called by villagers (Hasan 1961, p. 187). Lucknow villagers believe that dārū and other potent liquors provide strength, increase one's power of endurance, and make one immune to cold. Thus they are more used in the winter. Even women are sometimes given a little during lying-in periods, according to Hasan (Ibid., p. 176). Incidentally, the occasions of drinking by village men near Lucknow are usually accompanied by eating meat, spiced and fried potatoes, or similar spiced preparations. In the case of toddy, the alcoholic content is under 5% and this product, despite its disapproval by most government officials, orthodox Hindus, followers of Gandhi, and other prohibitionists in India, has long been recognized by nutritionists as a locally important dietetic source of vitamins B and C.[2] In North India its use is generally limited to lower castes (and even then only on infrequent festive occasions), but most villagers regard toddy as a strength-giving food, especially helpful to tuberculosis patients.

Just as liṭṭī or thick pulse-filled bread is in a sense symbolic of the winter diet, so is sattū or satuā the hallmark of summer. Sattū consists of grain that has been moistened, parched in hot sand, then

---

[1]The prices of these alcoholic drinks, as reported by Hasan, were approximately as follows about 1960: toddy--Rs. 0.19 a bottle (16 oz.?); dārū--Rs. 2.75 per pāv or quarter-seer (about 8 oz.); "country liquor"--Rs. 1.50 per pāv; and denatured spirit--Rs. 0.25 per pāv (Hasan 1961, pp. 174-192).

[2]Fermented drinks are very much more common among the slowly-vanishing "aboriginal tribes" of India than among the plains Hindus. Among the Korwas of Madhya Pradesh, for example, R. R. Sinha says of the popular rice beer: "They drink it for days together without taking food as the nutrients are not destroyed by fermentation" (R. R. Sinha 1967, p. 35). The "yeast" tablets used to ferment this rice beer must be made by herbal specialists from a combination of no less than 21 herbs--an example of how complex the superficially simple Indian dietary can in fact often be!

husked, cleaned, and ground into a coarse powder. It is generally made of barley combined with one of the pulses. In the case of poor people this pulse is frequently khesārī or latarī (Lathyrus sativus), a vetch widely cultivated in eastern U. P. and Bihar because it grows rapidly with a minimum of care on marginal land and with an exceptional ability to survive climatic vicissitudes (Lal 1945, p. 2). Khesari is relatively cheap,[1] and its leaves are also much used as a green vegetable, but when it makes up more than 25% of the diet it causes the dread and irreversible paralytic disease of lathyrism (Dwivedi and Prasad 1964, p. 115).[2] The more affluent farmers feed khesārī to their cattle and generally prefer a mixture of barley and Bengal gram, but more often than not the sattū eaten by the average person is composed of barley and peas or even khesārī. Sattū can be made also from maize,

---

[1]In the Patna city market between 1951 and 1964 khesārī sold between Rs. 19.26 (in 1954) and Rs. 55.57 (in 1964) per 100 kg. It stayed roughly comparable to barley in price during this period, and about 25% less than lentils and Bengal gram (K. Prasad 1967, Vol. I, p. 276).

[2]Even after years of research and a proliferation of theories, the exact etiology of lathyrism remains uncertain (see Patwardhan 1952, pp. 290-300). It may be partly the presence of selenium in the khesārī, interfering with methionine metabolism, that is at fault. It may sometimes be a pathogenic fungus which grows on the pulse during wet storage (The Wealth of India, 1962, Vol. VI, p. 41). Or it may be contamination by a toxic vetch (Vicia sativa, var. augustifolia), whose seeds are similar to but smaller than those of khesārī (Nicholls 1945, p. 298). At any rate, since khesārī is in practice almost always mixed with weed seeds, some of which are known to be quite poisonous, it has been prohibited from commercial sale under the Prevention of Food Adulteration Rules. At the same time, Indian plant scientists are trying to develop low-toxin strains of khesārī, and for the time being (since the vetch still remains a dietary necessity for millions of impoverished rural laborers) the Indian Council of Medical Research is recommending the parboiling of the khesārī seeds in order to remove about 90% of the toxic principle without incurring too much B-vitamin loss (Indian Council of Medical Research, 1968, p. 53).

millet, wheat or rice, but barley is the favorite, partly because barley is a "cold", "light", easily-digested cereal. In addition, barley, especially that of the new crop, makes an excellent parched flour but an indifferent bread, while the opposite is more true in the case of wheat.

> . . . wheat flour has certain unique properties which make it the flour of choice. The proteins of wheat flour gluten and gliadin when soaked in water form an elastic paste which holds on and permits of a considerable amount of stretching. (Indian Council of Medical Research, 1952, p. 44)

Barley also has an advantage over wheat in terms of price. The reader will obtain an approximate idea of the relative values attributed to some of the principal cereal and legume food sources in Uttar Pradesh from the average prices quoted, late in 1965, in rupees per quintal (one quintal = 100 kilograms):[1]

Rs. 87.51	Rice
Rs. 82.92	Lentils and such species of <u>Phaseolus</u> as <u>urad</u> ("black gram"), <u>mũg</u> ("green gram"), and <u>mōṭh</u> ("dew gram" or "aconite bean")
Rs. 77.85	Wheat
Rs. 71.63	Groundnuts

[1]Source: Uttar Pradesh. Directorate of Economics and Statistics. <u>Monthly Bulletin of Statistics</u>, Vol. 20, No. 2 (February 1966). It is interesting to compare these figures with those of 1882, as reported by Hunter (1886, Vol. VII, p. 157). At that time the average prices of foodgrains were:

Rice :	33 lb. per rupee	(or Rs. 6.67 per quintal)
Wheat :	39 lb. per rupee	(or Rs. 5.64 per quintal)
Sorghum:	74 lb. per rupee	(or Rs. 2.97 per quintal)

Since "coolies" received two annas or 1/8 rupee and bricklayers four annas in daily wages at that time, it can be seen that, despite the enormous inflation over the years, about the same wage-food price relationships have existed in India for at least 80 years. One difference is that sorghum is relatively more highly valued as a foodstuff now, and this fact is really an indication of a certain progressive impoverishment of the diet.

Rs. 63.03	Peas
Rs. 60.20	Bengal gram or chickpeas (<u>canā</u>)
Rs. 57.58	<u>Sā̃vā̃</u> millet
Rs. 54.87	Sorghum
Rs. 53.57	Pearl millet (*Pennisetum typhoideum*)
Rs. 53.01	Barley
Rs. 48.33	Maize
Rs. 35.93	Potatoes
Rs. 29.47	<u>Kōdō̃</u> (*Paspalum scrobiculatum*)[1]

Given the daily wage rate of about Rs. 2.00 for unskilled laborers in U. P. in 1966, this means that the laborer could buy 5 lb. of rice with his daily pay, or proportionately more of the other grains (e.g., 6 lb. of wheat, 8 lb. of sorghum, etc.).

Some words of caution are in order with respect to the staple foodstuff prices just quoted. The first concern seasonal variation in prices. Since man's requirements for daily food are fairly inflexible, it is clear that in a backward and unregulated peasant subsistence economy retail prices will peak at the time of shortest supply--just prior to harvest--and will fall precipitously during the harvest glut. In highly industrialized society, with efficient mechanisms of grain transport and storage, these seasonal variations can be almost eliminated. North India stands somewhere between the two extremes. In the case of

---

[1]The reader may rightly conclude that <u>kōdō̃</u> is a low-prestige, little-favored grain among North Indians in general (and its total production in U. P. in 1965, as reported in the source cited, was only 5% of the total wheat production). Yet, as Huntington once observed, "One of the queer things about all this is that when people become accustomed to a diet, even though it is of poor quality, they like it and believe it is good for them" (Huntington 1945, p. 457). And in the case of the lowly small millet, <u>kōdō̃</u>, this has become so completely a dietary mainstay of the Gond and Bhumia peoples of M. P. described by Fuchs that "If the Gond and Bhumia have the choice between wheat cakes or <u>kodai</u> (husked <u>kōdō̃</u>) cakes, they prefer <u>kodai</u> cakes" (Fuchs 1960, p. 64).

the two principal food grains, the "annual flux"--the range between the year's highest and lowest prices--has been reduced to 8% for wheat and 9% for rice in large cities such as Bombay and Calcutta (S. P. Sinha 1965, pp. 107-8). However, this author warns that these

> . . . market prices are based on dealers' prices. They are are not cultivators' prices. Naturally, it is possible to expect larger seasonal variation in the prices of rice and paddy in the rural areas. (Ibid., p. 110)

In fact, it appears that the seasonal range of variation in the North Indian countryside may still be surprisingly great, especially in the case of the inferior grains, a greater proportion of which are disposed of by the farmers immediately after harvest. In the case of maize a 12% range of variation in the years prior to 1965 was found to be typical in cities, but at Bahraich (north central U. P.) it was 43.2%, and at Agra sorghum had an annual range of 50.2% (Ibid., p. 111). In general, annual price flux is greater where supplies are relatively smaller.

Two or three other sources of price variation should also be noted. One is geographical, for in areas only a few hundred miles distant from each other in North India the retail prices of any given staple food commodity can vary at least 10%, and often much more. This may be in some part a reflection of regional variations in standards of living. For example, at least since 1960 (and probably for many years previous) the average wage rates in eastern U. P. have been about 20% lower than those of the average of the whole state, while the average wage rates in the "Hill" or sub-Himalayan districts have ranged from 15% (in 1960) to 80% (in 1965) higher than the U. P. average of Rs. 2.00 per day (in 1965-66) (U. P. Directorate of Economics and Statistics. Urban Wage Rates of Casual Unskilled Labourers in Uttar Pradesh, n.d., p. 2). However, relative local supply and demand are no doubt more important factors, and a comparison of the relative prices per quintal of various grains and pulses in Bihar with those in U. P. listed above, gives some indication of such regional differences (e.g., rice costs less in Bihar than in U. P., but wheat, Bengal gram, maize, and potatoes cost more) (K. Prasad 1967, Vol. I, pp. 271-276). Of course, year-to-year fluctuations, reflecting harvest fortunes, may also be considerable, as Prasad's table of 1951-1964 Patna city market retail prices shows (e.g., rice dropped from Rs. 55.67 per quintal in 1953 to Rs. 31.91 per quintal in 1955 and barley from Rs. 55.43 per quintal in 1951 to Rs. 19.96 per quintal in 1955). Since the bumper harvest year of 1955, the upward course of food prices in India has been relentless, however, with the sharpest jump coming in 1963-1965, when some prices doubled or trebled.

Finally, market prices such as those quoted here may be a little misleading, inasmuch as they represent average figures. But in fact nearly every cereal and pulse in the market is sold in at least two--and often several--varieties, grades and qualities, with a corresponding range in prices. For example, in a survey of the Varanasi retail market in 1964 I found that, while the average price of rice at retail was somewhere near Rs. 1.50 per seer (or about Rs. 82.50 per quintal), the finest and most expensive rice cost twice as much, while a very inferior variety could be purchased at less than two-thirds the "average" price. The rate quoted also varies according to whether the rice is new or old, whole or broken, and mahīn ("fine") or mōṭā ("thick, coarse").

To return to sattū, it is so much an institution[1] in North India that (at least in much of the Bhojpuri-speaking area) it is enshrined in the observance of satuāni, a day in the month of Cait (March-April) when Brahmans are ritually fed sattū and chutney made from unripe mangoes. Before this day, pious Hindus will not eat mangoes of the current year's crop. Although sattū is not much eaten in winter or the rainy season (it is believed to cause dysentery then), some is usually made from the new sāvā millet in August. And at this time the women offer this sattū to God first, since it is the first cereal food made available by the kharīf or rainy season crop.

[1]Sattū (Skt. saktū) and maṭṭhā are among the oldest known foods in India, being often mentioned in the Vedic literature. In the Kalpa-sutras--the works largely devoted to household ritual--a "maṭṭhā" made of parched barley-meal mixed with melted butter is recommended for Brahmans. For Kshatriyas, it should be stirred into milk. For Vaishyas, it is combined with curds, and for the Shudras, water suffices (Gopal 1959, p. 166). The varna hierarchy here specified perfectly matches the descending order of good qualities and virtues (and market prices) attributed to the present day to ghee, milk, curds and water.

Certainly, the special merits of sattū in the summer season are many. First, it provides a satisfactory method of processing the new grain, even before it is fully ripe, to make it digestible and palatable. North Indian villagers consider newly harvested grains of all kinds to be "hot" and hard to digest in comparison with old grain--that stored for some months or from the previous harvest. They complain of small "hairs" on new gram, barley, etc. which cause difficulties by sticking in the throat. Before using new grain, villagers like to soak it in water and then sun-dry it. According to staff members of the U. P. Provincial Hygiene Institute, it is a matter of empirical medical experience in North India that new grains tend to cause stomach upsets and non -bacterial diarrhea. This is especially true of new paddy, and in addition:

> Rice obtained from freshly harvested paddy cooks into a glutinous mass. There is no doubt that during storage the cooking quality improves. (Patwardhan 1952, p. 22)

In central U. P. pēcish, a term applied to a certain type of dysentery, is attributed mainly to eating flour made from new grain, especially that of wheat, barley, and gram (Hasan 1961, p. 232).

Secondly, sattū makes an excellent travel ration. When going on pilgrimages or on trips to the city for court cases or the like the villager can simply tie a pound or two of sattū in a cloth to carry along. It requires only water to be made palatable and it frees caste-conscious orthodox persons from concern with ritual pollution which might arise if they had to seek food from a vendor or food-stall. This is in addition to the expense and the dubious quality of food purchased away from home on the street.

Thirdly, sattū as the midday main cereal dish eliminates the necessity for the women of the family to squat in front of a cooking fire at the time of highest temperature. Of course, they do have to grind the sattū (about half an hour's work per pound of sattū, or enough to feed one hungry man), but this can be done in the early morning and the prior parching is taken care of by the village grain-parcher.

Finally, *sattū* is a relatively balanced and nutritious food, since it includes a combination of whole-grain cereals and protein-rich legumes. This is the case even if the outer bran is removed, since the grain is soaked before parching, a process which may produce a doubling of the mineral content and a six to ten-fold enrichment of vitamins in the endosperm, according to recent evidence (Rohrlich 1960). The real virtue of parching in increasing both digestibility and the biological values of the proteins has also been shown by scientific studies (Acharya, Niyogi, and Patwardhan 1942). The proteins of cereals and pulses are nutritionally complementary and the combination of the two in *sattū* is fitting, since they are often interplanted in the same field,[1] a traditional practice which one early British authority called "the most irrational practice that ever found existence in the agriculture of any nation", but one which in fact is a realistic adaptation to the climate, since

> . . . dew will form on the leaves of the legumes which would not form on wheat or barley, and in seasons of drought this may be the means of preserving both crops. (Elliot 1869, Vol. II, p. 332)

Sattū may be eaten dry, often with hot green pepper, or mixed with *guṛ*, but in the hot season a liquid is mixed with it--preferably buttermilk or curds, but in actuality usually water. There may be just enough liquid to moisten the *sattū* and allow it to be shaped into lumps or balls with the hand when eating, or a larger amount to produce a gruel or thick drink. *Sattū* is thought to require at least some salt to be palatable, although sweetened *sattū* is more favored in western U. P. and salted *sattū* in eastern U. P. and Bihar.[2] However, *sattū* of *s̃ā̃vā̃* millet, used by poorer people in eastern U. P. as the first available cereal to break the August lean period, is eaten with coarse sugar or *guṛ*.

---

[1] Pulses and cereals have also long been combined in "bread" or *capātīs*, but in recent years this type of pulse-cereal mixed *roṭī* has increasingly come to be regarded as an indication of low social status, and even the untouchable agricultural laborers, the Camars, are trying to give it up (Sen Gupta 1966). Mixed cropping has also declined in the past few years.

[2] This same pattern of preferences is also found with respect to *pannā*.

Ballia District in extreme eastern U. P. has a reputation as the heartland of sattū, and it is said that in Ballia (city) sattū is sold everywhere as a convenient ready-to-eat food at the foodstalls somewhat jocularly referred to as turanta hōṭals or "immediate-service cafes".[1] Sattū is in fact especially popular in all of Bihar and adjoining eastern U. P., probably because this is not primarily a wheat- or capātī-eating region but a rice-eating land.[2] ("Women in Ballia don't even know how to make capātīs", I was told, perhaps with some exaggeration). In western U. P., on the other hand, relatively more of the barley is used in combination with or as a substitute for wheat to make flat bread or rōṭīs. Incidentally, I found that in Varanasi in 1966 sattū (of a relatively poor quality) was selling at retail on the street at Rs. 2.25 per kilogram.

Many women informants in the area of Varanasi stated that a major difference in meals during the summer season, as compared to the rest of the year, is that they do not so consistently prepare the flat breads for the noon meal, and instead substitute sattū, boiled rice, etc. Or else barley or wheat are processed in the form of gūrhī. That is, the grain is parboiled, dried, and cracked to make a sort of bulgur. In this form the new grain becomes a "cold" food, and may be boiled like rice (gūrhī kā bhāt) or used in other ways.

The making of rōṭīs in the North Indian village manner requires the cook to squat in front of a fire, rolling out balls of dough into flat cakes on a rolling board and then cooking them on a concave griddle. The capātīs require constant attention and must be cooked one at a time, each being finished off by a momentary toasting directly on the coals. Thus, the preparation of the cereal staple alone for an average family may require an hour's exposure of the housewife to a microclimate ranging well over 130° F. Since most men do not much care

---

[1]The English word "hotel" (Hind. hōṭal) is generally understood to mean a small street-side restaurant, cafe or food-stall in North India.

[2]Crooke says that the best sattū contains a small proportion of rice flour (Crooke 1888, p. 254), but the only one of my informants who mentioned the inclusion of rice was an upper-class Muslim, who said that his family often drink a sharbat made from a sattū of rice and canā (Bengal gram).

for left-over capātīs, there may be no alternative to this ordeal for the women unless the husband or father-in-law is considerate enough to accept boiled rice, gūrhī or parched grains as a substitute. A boiled cereal, or bhāt, of course does not require this constant supervision while being cooked. Ordinarily, however, rice is preferred for the evening rather than for the noon meal (Hasan 1961, p. 129).

In cities such as New Delhi, incidentally, the rigors of hot-season capātī-making have helped to promote a new industry. According to an article on "Tandoori Rotiwala" in the Aug. 12, 1963 issue of The Times of India, the Panjab-style underground oven known as tandūr is becoming increasingly popular in New Delhi. A man who operates such a neighborhood oven on a commercial basis stated that his patronage occurs mostly in the summer. He claimed to net the equivalent of about U. S. $2.00 a day, selling each thick round cake of bread for less than one cent.

Although we would probably think of it as a dessert, the dish known as lapasī is considered a seasonal summer food in eastern U. P. Lapasī is made from wheat or barley flour fried in oil or ghee on a slow fire until browned. Twice the quantity of sugar and four times the quantity of water are added and it is cooked until slightly thickened. This gruel-like dish is believed to have some "lubricating" effect on the system, but its high liquid content seems particularly adapted to the hot-dry season.[1] It is clear from its list of relatively costly ingredients that the poorer classes do not often have an opportunity to savor it.

Most of my informants stated that in the hot-dry season their appetite is diminished, especially for the midday meal, and they tend to eat a relatively larger share of the day's calories at the late--and often very late--evening meal. This accords with the findings of nutritionists elsewhere of anorexia in hot weather, the tendency to transfer food intake from noon to evening (Johnson 1943, p. 5), and the likely desirability of eating snacks during the day rather than eating

[1]Mrs. Wiser found lapasī to be specially associated with the November Divali festival in Mainpuri District of western U. P. (C. Wiser 1955, p. 348). But it is more a summer food in eastern U. P.

a single midday meal in the heat (Wyss 1960).[1] However, there is no evidence to show that total caloric intake is less in North India in the hottest season than at other times of the year. Indeed, due to the occurrence of the wheat and barley harvest in April, average daily intakes are probably higher in the May-June hot season than at most other times of the year (Figures 4 and 6).

In addition to the enormous consumption of water and liquid foods and the tendency to eat somewhat more rice and *sattū*, urban informants indicated that in the hot-dry season they also consume relatively more of such seasonal vegetables as gourds, okra, *nenuā* (*Cucurbita pepo*), *parorā* (*Trichosanthes dioica*), bitter-gourd, etc. Raw onions are particularly popular in the summer season, and together with *capātīs* or rice they constitute a popular lunch for persons working in the fields.[2] The principal seasonal fruits are wood-apple (*bēl*), canteloupe, watermelon, jackfruit and mango (immature and ripening).

Although watermelon is universally regarded as cooling and healthful in the summer, people carefully avoid drinking water immediately after eating watermelon. I was solemnly told by many informants of illnesses, apparently gastro-intestinal disturbances, and even deaths which they attributed to this unwise practice. In fact, there is a general taboo against drinking water immediately after eating "cold" foods, such as guavas or custard apples. *Dahī* or curds (yoghurt) is a popular "cold" food, but is traditionally taken at the noon meal (Chopra 1963, p. 39). If eaten at night or in the cooler seasons, *dahī* should have some sweetener mixed with it to avoid too much "cold" effect. Milk and curds are tabooed at the same meal (as are milk and meat), and if milk is drunk it should be before the meal, not after it.

---

[1] South African gold miners, who work in one of the most heat-stressful industrial conditions in the world (96° F. dry bulb and 93° F. wet bulb temperatures), eat little or nothing during the day and consume a huge meal at night, according to a recent visitor (V. Johnson 1965). Likewise, at Keesler Field, Miss. in World War II, camp directives required the provision of only a light meal at noon, with a heavy one in the evening (Wallace 1943, p. 146).

[2] See pp. 238ff for a description of the very special role of onions in relation to heat-effects prophylaxis.

When informants were asked which foods should be avoided during the summer season the most frequent response was "hot" foods, especially meat, eggs, maize, millets, jackfruit, and spices having "hot" qualities. Typhoid, cholera, diarrhea, night blindness, eye inflammations, and other sicknesses prevalent at this time are widely ascribed to an excess of "heat" in the body, or indeed to environmental heat per se. In the case of night blindness, it is not vitamin A deficiency but the strong solar rays that are considered responsible (B. G. Prasad 1961, p. 230).

Other undesirable summer foods mentioned by some informants are wheat cakes, both in the form of _capātīs_ (dry-toasted) and _pūrīs_ (fried), tea, liquor, cigarettes, potatoes, _aravi_ (_Colocasia esculenta_), foods cooked in oil, left-over food, marijuana, ripe mangoes, etc. Many people stressed the importance of avoiding any kind of cut fruits or exposed food and especially of over-ripe and rotting fruits in the market place, observing that these cause cholera, gastro-enteritis, and other seasonal illnesses. Their emphasis seemed to be more on the fruits or food itself, however, than on the flies and pathogens. This is not surprising, in view of the village studies made by the Ford Foundation near Delhi about 10 years ago, and revealing that almost none of the villagers had any knowledge of what germs are (Taylor _et al_. 1965, p. 446).

C. Seasonal Diets and Food Sufficiency

Despite the elaborate and detailed Ayurvedic texts concerning proper dietaries and despite the quantity and variety of vegetables and fruits throughout the year in North Indian urban markets, the economic impoverishment of the great majority of people goes far to eliminate much possibility of choice. Dietary studies published to date indicate that at least 60% of the population are living so near the level of bare subsistence that their actual intake must be limited to the cheapest and most abundant cereals and legumes plus a few seasonally available fruits and vegetables.

There is little published evidence on the seasonal variations in diet for a single population sample in North India.

> In fact, in India extremely limited work on seasonal variation of diet has been done. (Roy 1966, p. 208)

Although Mitra asserts that "There is a school of thought rather inclined to make much of the changes in dietary pattern owing to the influence of seasons" (Mitra 1953, p. 2), most Indian nutritionists deprecate the significance of seasonal differences. Some even minimize the importance of regional factors:

> To a casual observer the dietaries of the people of the various regions in India appear to be materially different in composition and nutritive value. The differences which exist are, however, superficial and originate in the different methods of preparation of various foods and not so much in the average composition of the diet. It cannot be denied, however, that the former can materially alter the nutritive value of foods and thus bring about differences in diet which should be more deep seated than a mere enumeration of foodstuffs would indicate. But . . . cooking practices in India are generally not so drastic as to make significant variations in the nutritive value of foods consumed. Basically the dietary habits conform to a certain well known pattern. (Patwardhan 1952, p. 135)

The human body can tolerate reasonably well two or three months of vitamin A, vitamin C, and calcium deficiencies, which appear to be the most variable seasonally (Rao et al. 1961). And, as was noted before, Indian nutritionists are generally much less concerned by seasonal variations than by the serious and chronic overall food inadequacy. They feel that the socio-economic level is the essential determinant of nutritional sufficiency. As the National Planning Committee, with barely concealed anger, put the matter shortly after Independence:

> Every calculation of the wealth of this country, or of its per capita income per annum, shows barely 4 as. per day, or Rs. 80 per head per annum. Translated into terms of the necessaries of life, this means barely sufficient to provide one meal per day, and that of the coarsest material, without anything left over for clothing or shelter, not to speak of education or amusement. That is why it sounds a queer irony and a cruel mockery when public health enthusiasts speak . . . of balanced dietary, of sufficient and varied food and

> drink, clothes and house room, with a view to promote public health in the masses of India. (National Planning Committee 1948, p. 18)

The passage of more than 22 years may have brought some amelioration of these stark conditions, but there is little ground for complacency among nutritionists when one looks at the dramatic (and apparently widening) gap between the highest and the lowest 20% strata of the population (see, for example, Shukla n.d. and Chatterjee, Sarkar, and Paul 1966).

There is also the problem of unequal distribution of food within the family, and the fact that ritual prohibitions in some areas can selectively and unwittingly discriminate against small children, as Jelliffe (1957, pp. 131ff) has so clearly shown. Rao and his colleagues concluded from their study in North Arcot, Madras that

> Males obtain the best of the diet. In any shortage, the female members of the family, particularly the older females, suffer. A nursing or expectant mother gets nothing extra in spite of the strain of repeated pregnancies and the maintenance of children. (Rao _et al_. 1961, p. 321)

The situation appears to be not very dissimilar in North India, where Sukhatme points to family budget data indicating that

> The existence of undernutrition in a household does not mean that every member of the household is necessarily undernourished. Food is not distributed in proportion to needs, especially in poor households. Earners for example might take an adequate share of the food, leaving children to feed on much less than what they need. (Sukhatme 1965, p. 51)

So far as eastern U. P. is concerned, K. D. Upadhyaya has content-analyzed the large repertoire of Bhojpuri folklore, and summarizes:

> The study of Bhojpuri folktales led us to the conclusion that women do not possess a very high position in society. They are treated as the personal property of the man who can dispose them off in any manner he likes.

> The wife has no separate existence apart from the husband who is regarded as all powerful. (Upadhyaya 1968, p. 243)

This of course constitutes something of an overstatement or a caricature, as is obvious to anyone who has been privy to the inner workings of village households and has thus seen any number of these in which the senior female has effectively pre-empted awesome power over the cowed male members. However, no amount of rationalizing can hide the fact that, especially among the conservative segments of society, the weakest links in family mental and physical health are usually those individuals in the roles of daughter-in-law (especially, until she has borne a son), of widow, of younger children in a poor family of many children, etc.

In reference to seasonal diets, there seems to have been an understandable tendency by officials to avoid the hot season as a time to conduct dietary surveys in India, as the literature shows (Wilson and Widdowson 1952, p. 6). Field records of dietary studies stored at the U. P. Provincial Hygiene Institute in Lucknow and in the Nutrition Branch of the Public Health Institute in Patna might be profitably analyzed for more precise data on the nature of seasonal variations in diet. For that matter, the whole subject of dietary and culinary ethnology constitutes a virtually untilled field of study in India. The hundreds of existing diet surveys are unfortunately published in a form which is tantalizing but not illuminating to someone who wants to know exactly what is the actual food eaten by people, with their precise variations in content, preparation and amount based upon differences in season, individual proclivity, family habit, subgroup culture, socio-economic level, etc. As the most recent published review of overall food sufficienty in India presents it:

> Many factors affect the amount of food consumed--for example, age, sex, occupation, income level, rural versus urban population, vegetarian and non-vegetarian diets, body size, temperature, and pregnancy--and for most of these usable data do not exist. (Chakravarti 1970, p. 214)

Studies such as that of Ayyar and Shrivastava (1968) in Sagar District of Madhya Pradesh may be a portent of increased attention to those extensive variations in Indian diets which some experts have shrugged off as "superficial" and "well-known".

In general and broad terms it is recognized that in normal years the relative abundance and shortage of food in the rural areas follows a definite seasonal cycle. Yet, at any given place in North India probably one year in three is distinctly abnormal due to the effects of drought, floods, freeze, hail, insects, plant diseases, etc. And almost every year there are districts somewhere in Bihar and U. P. where, as a result of one or more of these calamities, people are threatened with starvation. The "normal" seasonal cycle of food sufficiency may vary from region to region, but in the village of Madhopur near Varanasi in eastern U. P. it may be roughly approximated in the manner shown in Figure 6. This diagram attempts simply to indicate the villagers' sense of food sufficiency, which means essentially the amount of grains and legumes in their diet. The close correspondence of this data to the harvest cycle (winter rabī crop harvest of wheat, barley and peas in March-April; rainy season kharīf crop harvest of maize, millet and rice in September-October) is very clear. But in addition to this primary cycle of major crops there are many special periods during the year when one or another locally-important foodstuff may be seasonally available in plenty, e.g., mangoes (May-June),[1] green peas and canā leaves (February), in March and April the sweet fleshy flowers of mahuā (Bassia latifolia, the Indian "butter-tree"),[2] and at other times potatoes and other tubers,

---

[1]Based on production figures quoted in The Wealth of India (Vol. VI, p. 266), over 60 lb. of mangoes were produced for every man, woman, and child in Uttar Pradesh in 1955. But mango acreage estimates for 1960 were 25% below those of five years earlier (May 1961, p. 236). An assumed annual production of 45 pounds of mangoes per capita is, in theory, equal to 56 grams per capita per day. However, even if this assumed production is correct, only a small proportion of it would refer to the use of the fresh ripe fruit, whose season in most villages does not extent beyond a month or two. Not all the seasonal glut of mangoes is wasted, however, as some of it is preserved in the form of pickles, dried pulp, etc.

[2]Mahuā flowers are 72.9% sugar, according to The Wealth of India (Vol. VI, p. 214). But they are flavorful, and either liquor or flour can be made from them, depending on how they are processed (Fuchs 1960, p.66).

wild "spinaches", and water plants such as lotus and water caltrop.[1] Many kinds of minor fruits and berries are available to the poor without payment, according to K. Prasad (1967, Vol. I, p. 286).

One foodstuff whose importance should never be underrated in North India is sugar cane. In one of his stories (Mukti-Mārg, or "The Road to Salvation"), the great Hindi short story writer Premchand says:

> Sugarcane isn't only the farmers' wealth; their whole way of life depends on it. With the help of the cane they get through the winter. They drink the cane juice, warm themselves from fires made of its leaves and feed their livestock on the cuttings. (Srivastava 1969, p. 24)

Fresh sugar cane and cane juice are in good supply especially from November to March,[2] and the crude sugar (jaggery or gur) that is reduced from the juice may be stored year-round. The local importance of cane and its products can be seen from a study by B. B. Singh of the sources of calories available for food in 54 villages of a Rural Development Block in Meerut District. Here some 73% of the total available calories are made up by sugar cane, with a range from 55% to 85% in individual villages (B. B. Singh 1968, p.69).

During certain periods of the year there may also be an almost complete absence of foods which provide the major sources of certain essential vitamins and minerals. For example, Roy and Rao found the

---

[1]The subtropical forest (Hind. jangal) is now greatly reduced in North India, except in fringe areas, such as those inhabited by semi-aboriginals in southern Bihar, in Madhya Pradesh, and in the sub-Himalayan tarāi. Yet, almost everywhere it is still a source of at least some "wild" foodstuffs and many medicinal plants (and animals), and it provides such groups as the Gond and Bhumiya with "a rich supply of vegetables which are eaten with the cereals" (Fuchs 1960, p. 64). Fuchs has inventoried the wild foods in considerable detail.

[2]In theory, at least, Hindus refuse to chew sugar cane before the eleventh day of the light half of Kartik (about November 9), when a first-fruits offering is made (Planalp 1956, p. 338).

ANNUAL CYCLE OF LOWER - CASTE FOOD SUFFICIENCY IN MADHOPUR, UTTAR PRADESH, INDIA

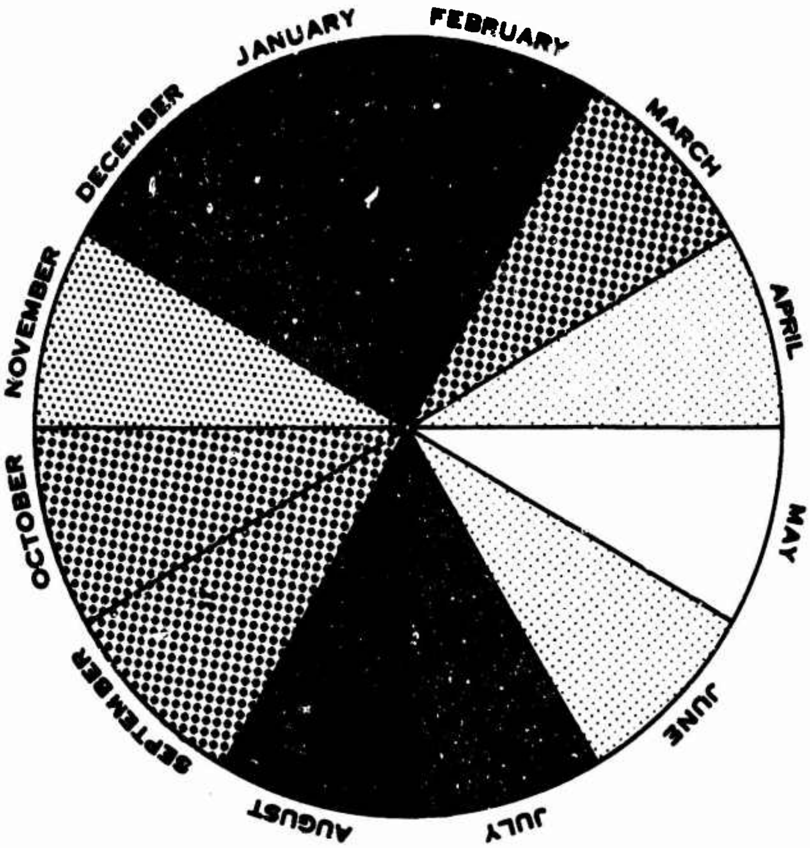

Figure 6. Annual Cycle of Lower-caste Food Sufficiency in Madhopur, Uttar Pradesh, India

This figure is based upon queries directed to a panel of 15 lower-caste (Camār) informants by Dr. B. S. Cohn in 1952-1953. It portrays the adequacy of food intake during normal years in the consensus of the panel, the extremes occurring in May, when all 15 respondents felt "satisfied" with the amount of food they were getting, and January-February, when 14 of the 15 reported semi-starvation in average years. Six degrees of food sufficiency are arbitrarily designated here and the approximate weight of the intermediate levels may be indicated by the fact that in April and June about half the respondents were "satisfied" while half were "hungry much of the time", and in July and December half were "hungry much of the time" while half reported semi-starvation or severe shortage of food. Despite the evident impreciseness and subjective basis of this chart, it matches closely the experience of Indian nutritional and agricultural experts in this area.

following seasonal variations in daily intakes of certain nutrients in a rural area of West Bengal:

Month	Calcium (mg.)	Vitamin A (I. U.)	Vitamin C (mg.)
July	540	3220	160
November	270	460	14
January-February	500	970	45

(Roy and Rao 1961, p. 101)

These are rather large variations,[1] but are not entirely comparable with Figure 6 because they derive from a region that is some 350 miles from Varanasi, and with a rather different crop regime.

North Indian cities, unlike most villages, enjoy relatively good transportation links with nearby market gardening communities and some fruit and vegetables may even arrive from other parts of the country, shipped by train and truck. Wage scales are also higher in cities, although in recent years urban dwellers have been severely squeezed by

[1]Note that there are very large differences in fruit consumption reported among different regions of India, e.g., 18 grams per capita per day in Bengal, but less than one gram in Rajasthan, according to Shirur (1967, p. 24). In addition, fruits vary enormously in their specific vitamin content, as may be illustrated by three examples: (1) custard apples have no vitamin A and only 16 mg. of vitamin C per 100 grams, but have 398 mg. (half the daily requirement) of calcium per 100 grams; (2) mangoes have only 10 mg. of calcium and 13 mg. of vitamin C per 100 grams, but 4800 International Units of vitamin A; and (3) guavas have only 10 mg. of calcium and no vitamin A, but 212 mg. of vitamin C per 100 grams. For comparison, the orange, a fruit that is intermediate in all respects, has 326 I. U. of vitamin A, 50 mg. of calcium, and 68 mg. of vitamin C per 100 grams (Ibid., p. 23). These two factors of regional variation in fruit intake and intra-specific differences in vitamin and mineral content, combined with the extreme seasonality of fruit availability, show why generalizations on Indian dietary adequacy are so difficult to make.

a continuing inflation. (Agricultural workers of course are generally paid in kind, and even their purchases of salt, oil and other sundries from the village shopkeeper are frequently made by barter.) Urban diets are thus not so acutely affected by the harvest regimes, and certainly members of the upper and middle classes are able to select and choose among many alternative foodstuffs. Nevertheless, the typical diets of the poorest urban groups, such as have been reported in various dietary studies, do not compare favorably with poor rural diets. For one thing,

> . . . poorer families must buy in the cheapest town market. Thus, in rice-eating areas urban life means machine-polished rice tends to replace hand-milled grain, while in northern towns dairy products largely disappear from a poor man's menu. (Wilson and Widdowson 1952, p. 8)

It may seem strange that so little has been said in all the above discussion about the dietary question of "vegetarianism" in India, and indeed about the consumption of meat at all. There are no reliable estimates for India of the regional and overall amount of "vegetarianism", defined as abstention on religious or moral grounds, from "meat", however defined.

> Vegetarianism has a wide variety of interpretations: for some it means refraining from eating beef only; for others no red meat is eaten; for others no meat and no fowl; for others no meat, no fowl, and no fish; for still others no meat, no fowl, no fish, and no animal products such as milk and eggs. (Organ 1970, p. 81)

(And, it may be added, to some Hindus it matters whether the egg is or is not fertile.) At any rate, the brief statistics derived from the middle-upper class urban sample described in Chapter I (see p. above) may be noted: 44% occasionally eat mutton, 23% eggs, 8% chicken, and 2% beef. Almost no segments of the population in Bengal taboo fish in their diet, even though in practice few can afford it.[1]

---

[1]Anyone interested in the often indirect yet potent ways in which ritual and sociocultural considerations can block utilization of otherwise readily available animal protein sources should refer to Jelliffe's analysis of nutrition in rural West Bengal (Jelliffe 1957).

Vegetarianism, however, defined, has the sanction of Brahmanical precepts, of the Jain religion, and of the Buddhist and the "non-violence" (ahimsa) teachings.[1] In modern popular terms, however, it is mainly associated with the best-known and ritually dominant of the four recognized sect-traditions within Hinduism, the Vaishnavite (see Sharma n.d.). Those individuals, families, castes, communities, or regions who pay especial devotion to the incarnations of Vishnu--either Rama or Krishna, or both--are almost wholly vegetarians-on-principle.[2] So too are those who follow another of the four major sect-traditions, the Smartas (that is, the "orthodox" or adherents to the smritis--the ancient laws, usages and traditions). Even the more devout Hindus within the Shaivite sect-tradition are vegetarians-on-principle, but most of the Shaivites, as well as the Hindus of the fourth major sect-tradition, the Shaktas, are meat-eaters.[3]

Muslims are usually thought to be dedicated meat-eaters, accounting for most of what little beef is eaten in North India. And so most of them probably are (although considerable beef is also consumed by Christians). Yet, there are some villages where a majority of Muslims are also found to be vegetarians-on-principle, such as in Sumbhadih, a village in Phoolpur tahsil of Azamgarh District (Census of India, 1961, Vol. XV. Uttar Pradesh. Part VI. Village Monograph No. 7, p. 14).

---

[1]The great priest-physician Caraka made short shrift of complaints by Buddhists and other advocates of ahimsā about the meat-eating recommendations in Ayurvedic texts. He is quoted as retorting: ". . . the object of Ayurveda is not to point out the way to Emancipation by acquiring righteousness but the preservation of health." (Kaviratna 1890-1901, p. 101n)

[2]So highly correlated with vegetarianism is Vaishnavism in the popular mind that vegetarian restaurants or food-stalls in cities are called "Vaishnava Bhojnalayas", not "Shakahari (vegetarian) Bhojnalayas". Vaishnavas also forbid certain vegetables: onions, garlic, chillies, and even potatoes (Sharma n.d., p. 47)

[3]Sharma says that most of the Thakurs, the predominant land-owners of North India, are basically Shaktas (Ibid., p. 53). His seemingly very loose definition of sect-adherence would presumably also include as Shaktas most of the large untouchable Camar population of landless laborers, who in general have no Hindu ritual standing or sophisticated theological pretensions.

Some of the societal segments in North India which do, in fact, contain a large propertion of strict vegetarians are: certain castes and caste groups, such as Brahmans, Vaishyas, Ahirs (cow-herders), and Koeris (vegetable-growers); Jains; followers of the Arya Samaj; Vaishnavites and Smartas; widows; old people; sādhus or religious mendicants; and individuals who become religious devotees while they continue in normal life (the so-called bhagats or pujārīs) (Planalp 1956, p. 783). Those Hindus who are really orthodox, especially among the Brahman castes, carry their strict vegetarianism even further. They have long rejected masūr or lentils (Lens esculenta) (Mazumdar 1960, pp. 258-261), and their rationalization ("because lentils are reddish like meat") is probably not the real reason for this ancient antipathy. They also traditionally taboo onions and garlic, citing the myth that when Brahma created men and animals he had some flesh left over and, not knowing what else to do with it, he molded it into these two plants. Cabbage, eggplants, mushrooms--these are other food plants frequently despised by orthodox Brahmans, and the list of orthodox-tabooed combinations of foods (that is, when eaten at the same meal), or of foods not permissible at specific astrologically-determined times, is a complex and lengthy one.

My own guesstimate (and in the absence of extensive and reliable surveys it can be nothing more than that) is that probably only 30% to 40% of the whole population of North India (U. P. and Bihar) at the present time are really vegetarians-on-principle. (Of course, random samples taken from such selected groups as hostel students often yield a much higher proportion of "vegetarians", whether strict or nominal.)

Whatever the actual percentage of vegetarians-on-principle, the number of people who for all practical purposes are also vegetarians (but "vegetarians-by-necessity") is at least as great. The typical village family described by the Ford Foundation team (Taylor et al. 1965, p. 126) ate meat twice a year; they could afford it no more often. Both the overall food balance sheets and the majority of dietary surveys over the years and up to the present time in India are in agreement that the average caloric intake in the adult Indian diet derived from meat, eggs and fish is in the vicinity of 10 to 15 calories (0.3 to 0.5 oz.) per day (May 1961, pp. 247ff; Sukhatme 1965, p. 80). The proteins derived from this quantity of meat constitute only about 2% of the average daily protein intake of 50.4 grams per day. (Some 87% is supplied by cereals and legumes, and only another 9% by milk and milk products.) The typical state-wide

Uttar Pradesh schoolboy diets reported by Govil, Mitra and Pant (1953) are even more devoid of animal proteins. Although they averaged a high daily caloric intake per consumption unit of 2757 calories, and a protein intake of 85.6 grams, practically none of this protein derived from meat (only one hostel was non-vegetarian), and only 1.9 grams of protein derived from animal sources, that is, from dairy products.

The relative dearth of milk in a vegetarian diet is especially worrisome to nutritionists. A survey of some 28,000 families near Indore, for example, showed that of the 63.4% of these families who owned no milk-producing animal, only 10% ever purchased milk for family use (Lal Chand 1963). Of course, if a survey such as this included purchases of non-liquid milk products, the percentage of at least occasional buyers would be much higher. Sweetmeats are made from milk that has been boiled down and concentrated in any of various ways, or they may be prepared from "split" milk (reduced to casein by means of citric acid, lactic acid, alum or the like). However obtained, the milk solid can be combined in any of a great many ways with sugar, flavorings and other ingredients.[1] As noted in Chapter II, such sweetmeats were once an important staple food, at least among the more prosperous elements of North Indian society. Even though today they make but a rare festive contribution to the diet of the average Indian, it was calculated, as of 1956, that only 41% of U. P.'s total milk production was used as fluid milk. About 35% went into the making of ghee and butter, and the remaining 24% for "other purposes", presumably sweetmeats, "cheese",[2] etc. It is not clear whether yoghurt or curds (<u>dahī</u>) was included with "fluid milk" or with "other purposes" in this breakdown, but in any event relatively few adults drink "fresh" milk, preferring it, if in liquid form at all, as <u>matthā</u>, <u>lassī</u>, or curds-with-water. Whenever milk is drunk "fresh" (but always after boiling,

[1]The number of Hindi-language cookbooks that have been published in India may well total several score by now, although many are rather derivative. Among the dozen in my own library, the following contain excellent sections on milk sweetmeats, with recipes: Joshi 1951, pp. 116ff; A. C. Shukla 1956, n.p.; Bhargava 1958, pp. 272ff.; Katara 1960, pp. 104ff; and Thakur 1961, pp. 168ff.

[2]This is <u>panīr</u>, a kind of pressed and dried curds. Ripened, fermented or hardened rennet-produced cheese in the Western sense is not an indigenous Indian product, but enjoys a growing market today.

at least briefly), it is sweetened with sugar and is drunk hot or lukewarm. "Fresh" or "sweet" milk is considerably more popular in western than in eastern U. P. (and is also in greater supply there).

There is, unfortunately, no space here to describe the numerous indigenous milk products which are made in India by means of various techniques of boiling down and coagulating milk (see, for example, Davies 1940, Rangappa and Achaya 1948, and De and Ray 1952). Some of the most common such distinctive milk products are malāī, rabaṛī, khoā, chēnā, khurcan, māvā, and khīr. It would be difficult to give approximate English equivalents, such as clotted cream, condensed milk, etc., partly because even the fresh milk of Zebu cows, and especially of buffaloes, seems to have a flavor and texture that is unfamiliar to Americans, while the more solid, condensed products are even more exotic.

Cow milk is considered more "cold", more "light" (halkā), and easier to digest than buffalo milk. In fact, in Hasan's village it is either not given to infants and children, or else it is diluted with an equal amount of water to make it more "light" and digestible (Hasan 1961, p. 140).[1] Buffalo milk has a higher butterfat content,

[1] Incidentally, adulteration of milk is very common in India, and is often officially decried. But Hasan's careful village study indicates that milk adulteration is not always simply a matter of economics or of coldly-calculated deceit. In the Lucknow rural area there is a strong deep-seated magical belief that if pure milk is boiled, the mammary glands of the donor animal may be affected by itching or burns (Hasan 1961, p. 140). Because of this idea it is almost impossible to obtain pure milk in the locality. Some suggestion that the watering of milk by the cowherding caste may have rather widespread ritual or social meaning also emerges from an anecdote related by Mrs. Ashby in Gaya, Bihar. In ultimate desperation at not being able to obtain undiluted milk from the gvālā (milk-seller, member of the cowherding caste), she offered to pay double the price, or half a rupee a seer instead of one-fourth rupee. She reports his interesting reply: "'I cannot sell pure milk, Memsahib. No gwala can. It is against the rules of our gwala community. The brotherhood knows the cattle we have, and the daily produce of each. For one rupee a seer, I could not supply you milk without water'" (Ashby 1937, p. 163).

and the average village buffalo of course yields more than twice as much milk as the average cow.[1] Goat milk is not generally well liked, and is not much used, being limited mostly to babies,[2] old people, and persons suffering from asthma, tuberculosis, etc. (Behura 1962, p. 127; Patwardhan 1952, p. 11).

It has always been recognized that the conversion of a large proportion of milk in India into ghee, curds, etc. has been dictated by the lack of refrigeration, and the rapid spoiling of the fresh product. Perhaps Indians have surmised from long experience that

> The organisms of dysentery, typhoid and other diseases grow rapidly in milk in warm climates, and milk once infected may in a few hours be so heavily charged with some pathogenic organism that it can lead to an overwhelming infection, such as fulminating bacillary dysentery in children. (Nicholls 1945, p. 239)

However, the recent evidence of ethnic or racial variations in lactase deficiency and lactose intolerance may introduce a complicating explanatory factor. Whatever the outcome of the heated scientific arguments

---

[1]The composition of Zebu cow milk is 4.1% fat, 4.4% sugar and 3.2% protein, whereas that of buffalo milk is 8.8% fat, 5.1% sugar and 4.3% protein (Nagarajan 1968, p. 27). Das Gupta is among those who bitterly decry the manner in which the she-buffalo population in North India has expanded at the expense of cows. He attributes this to the growth of the commercial ghee trade, to the fact that female buffaloes, unlike cows, can be milked in the absence of their calves, and to the fact that Hindus, who in theory do not permit cow-killing, are in practice more hypocritical in regard to buffaloes than to cows, and show little compunction in permitting the male buffalo calves (for which there is little commercial demand) to starve to death (Das Gupta 1945, Vol. I, p. 311).

[2]This is despite the alleged unsuitability of goat milk in an infant diet by reason of certain insoluble acids (Gangulee 1939, p. 166). But goat milk is comparatively rich in iodine, vitamin B, and other inorganic constituents. In village folk belief, goat milk is "cold" and is prescribed medicinally (Hasan 1961, p. 81). Unfortunately, since in this case the milk is used raw, it may help spread fevers of the Malta Fever type (Norman-Walker 1943, p. 50). A well-tended Indian nanny goat yields 200 lb. of milk per annum (Husain 1951, p. 152).

as to an adaptive versus a genetic basis for the condition (see Time, July 13, 1970, p. 59), the existing literature clearly documents the existence of a high frequency of milk or lactose intolerance among non-European adults (e.g., Huang and Bayless 1968; Alzate, Gonzalez and Guzman 1969; Flatz, Saengudom and Sanguanbhokin 1969; Bolin and Davis 1969; and Keusch et al. 1969).

The National Council of Applied Economic Research, in its Techno-Economic Survey of Uttar Pradesh, has published somewhat puzzling data on milk production in the state. They estimate total milk production in 1956 at 144 million maunds, or 11,808,000,000 lb., with an 8.25 oz. daily per capita consumption (NCAER 1965, p. 46).[1] However, they also describe a 1961 milch animal population of 2.73 million cows and 3.12 million buffaloes, yielding an average of 643 lb. and 1566 lb. of milk respectively per annum, or a total of 6,641,310,000 lb. The two production figures are difficult to reconcile, even if one assumes that goat milk production may have been included in the overall milk estimate. There were about 6 million goats in U. P. at this time, compared with 10 million buffaloes and 23 million cattle (May 1961, p. 243; NCAER 1965, p. 252).[2] Since goat milk production was probably not much more than 100,000,000 lb. in 1961, how is one to account for the indicated decline in 1961 to only 60% of the milk production of five years earlier?

For India as a whole (in 1957), 30% more fish was eaten than all other meats combined (May 1961, p. 251).[3] According to the FAO food

---

[1]This compares with an all-India figure of 5.27 oz. per day, a slight decline from the 5.6 - 5.9 oz. daily per capita average which Patwardhan claims had prevailed in India for many years (Patwardhan 1952, p. 56). According to Agrawal and Bansil (1969, p. 25), all-India per capita milk consumption in 1966 had declined to 4.5 oz. per day.

[2]These are of course total figures, including young, old male and female animals. In 1966 there were 20 million cattle over 3 years old, and 7.4 million buffaloes over 3 years old in Uttar Pradesh (Agrawal and Bansil 1969, p. 23).

[3]However, the average of fish consumption in the inland states of U. P. and Bihar is much lower than the all-India average.

balance sheets, the flesh of goats makes up about 30% of the total meat consumption, that of sheep and cattle 20% each, of water buffalo 15%, of poultry 10%, and pork about 5% (May 1961, p. 251).[1] Most "beef" (cattle and buffalo meat) is no doubt eaten by Muslims and Christians. Goats are not only more than three times as numerous than sheep in North India (Agrawal and Bansil 1969, p.23), but their flesh is also more highly prized (Jayaswal 1948, p. 48). It is considered less "hot", for one thing. As to relative costs, about 1959-60 in the Lucknow area "mutton" (mostly goat meat) sold at Rs. 1.75 - 2.00 a seer, while "beef" (buffalo meat) was only Rs. 0.50 a seer (Hasan 1961, p. 142) Chicken meat is relatively expensive--perhaps twice the cost of mutton, although I do not have exact figures[2]--and this is despite the claim sometimes made that, in the words of Gangulee,

> Poultry farming is undeveloped and therefore the kind of chicken usually sold in Indian markets is scarcely fit for human consumption. (Gangulee 1939, p. 174)

Similarly,

> Since no care is taken to develop the livestock, most meats in India are thin, tough, and poor in fat content as well as in the quality of proteins. (Ibid., p. 174)

---

[1] I believe that figures of this sort involve a large element of guess-work, in the absence of reliable knowledge about the extent of home slaughtering and surreptitious or illegal slaughter ("cow-slaughter" is officially banned in several Indian states, including U. P. and Bihar). No state-by-state breakdown of these figures is available to me, but I suspect that, in terms of percentages, these all-India figures somewhat exceed those in U. P. and Bihar for consumption of sheep meat, and are somewhat lower for consumption of goat meat. Similarly, it is doubtful that a majority of North Indian "beef" derives from cattle rather than water buffaloes.

[2] In 1966 the poultry population was estimated at 3,771,000 in U. P., but at 10,849,000 in Bihar (Agrawal and Bansil 1969, p. 23).

We have seen, in Section A above, that the Indian Council of Medical Research's Nutrition Advisory Committee takes approximately 2430 calories per day as the average Indian adult energy requirement. Sukhatme (Feeding India's Growing Millions) leans toward a minimum requirement of 2300 calories, and designates diets under 2150 calories as definitely undernourished. The principal question, however, and one whose answer is wreathed in confusion and heated arguments, is that of precisely what the average Indian daily caloric intake is.

There is no disagreement about the fact that there is huge variation in actual caloric intakes in India, among different segments of the society, and sometimes in the same group from one time to another.

> . . . according to 132 surveys made between 1931 and 1942, the average caloric intake amounted to 2,560 calories per consumption unit per day (in 92 surveys, the caloric intake was between 2,000 and 3,000, in 28 surveys, it was between 3,000 and 4,300, in 17 surveys it stood between 1,100 and 1,500). (May 1961, p. 219)

This great range in Indian sub-group diets is probably no less today than it was in the 1930's. This information is very graphically shown in map form by Learmonth (1956, p. 212). Many authors have based their conclusions on 12,500 household surveys lasting from 7 to 21 days, made between 1935 and 1948, in which foods were actually weighed twice a day (Sukhatme 1965, p. 47). However, the original survey materials have never been published, according to Sukhatme, and anyone who has seen or participated in the procedure of such food weighment studies must be aware that the method is far from foolproof. It is very difficult to estimate in Indian villages the amount of food that may be consumed as "snacks" outside the house. For example,

> Social customs and conventions permit the poor to help themselves to . . . [prunings of young pea, gram, khesari and other plants] . . . from anybody's fields until the plants are in flower. (K. Prasad 1967, Vol. I, p. 285)

Of course, however vitamin-rich, most of these snacks have little caloric significance, and the actual weighment of meals is certainly much superior to recall questionnaires, which have proved to be almost useless in India. To serve as a reliable basis for national food intake projections, however, the household consumption studies must be based on representative samples, and those carried out from 1935 to 1948 were not so. Thus, government planners and economists have generally favored a "food balance sheet" approach, derived from production data, with appropriate subtractions for exports, storage losses, seed reserve, etc.

All the authorities agree that the Indian nutritional situation gradually deteriorated during and after World War II, but there is considerable difference of opinion as to how much it fell, and when the low point was reached, whether as early as 1953 or as recently as 1967. May's food balance sheets (based on Food and Agriculture Organization tabulations) show a daily adult caloric intake of only 1710 calories in 1953, and of 1890 calories in the 1955-1957 period. These figures are generally comparable with some others which have derived from semi-official Indian government sources. Thus, Dutt (1962, p. 15) cites 1800 daily adult calories for India as a whole (compared to 2000 calories in Pakistan, 2200 calories in Japan, and 3100 calories in the U. S. A.), and a current article in India News (information organ of the Indian Embassy in Washington, D. C.) says:

> In India, the calorie intake per person is expected to go up from the present level of 1965 to 2300 by 1981. (Mathrani 1970, p. 2)

However, side-by-side with these all-India average intake figures in the area of 1900 to 2000 calories per day, one can find a series of others from equally responsible sources which consistently place the average daily calorie intake per adult at close to 2400 calories per day. Thus, according to Rao, the figure was 2440 calories in 1953, 2300 calories in 1958, and 2260 calories in 1963 (Rao 1967, p. 4). The eminent nutritionists Swaminathan and Raghavan accept similar values (Swaminathan and Raghavan 1966, p. 66). According to Sukhatme, the difference in opinion is traceable to the First Round of the National Sample Survey, in which interview methods were used separately to derive estimates of total food production on the one hand, and of food consumption on the other hand. When the two results were compared, there was an enormous discrepancy of 30 million tons--39 million tons according to production estimates, and 69 million tons based on consumption estimates (Sukhatme 1965, p. 15). The discrepancy translates to a difference in daily average per capita caloric intake of

2000 calories versus 2400 calories. The N. S. S. report dismissed the crop production data as a gross underestimate and accepted the higher figure, leading some writers to conclude that there is negligible undernourishment in India. Moreover, improved versions of the food consumption surveys up to the 14th Round of the N. S. S. have continued to show cereal consumption at the level of 530 g. per head per day, although the food balance sheet for India seems to document the impossibility of more than a 375 g. daily cereal consumption (Ibid., p. 17). The difference is a critical one--some 400 or 500 calories--and precisely bridges the difference between barely adequate average nutrition and very widespread malnutrition. Sukhatme argues strongly for the validity of the rather pessimistic food balance sheet findings, and most outside observers appear to agree with him.[1]

These are all-India statistics, and there are rather marked differences among the various states or regions of the country. The following table shows average daily dietary intakes of principal food categories, as calculated by the Indian Council of Medical Research:

---

[1]An additional explanation for some of the discrepancies in expert appraisals of India's food sufficiency may lie in a differential employment of "per capita", "per adult", or "per consumption unit" measures. It is the last of these to which nutritionists usually refer, but their definitions may not always be the same. Thus, according to the most recent guidelines of the Indian Council of Medical Research, adult males and adolescents in the 12 - 21 year age range are calculated as 1.0 consumption unit, while adult females are 0.9, children 9 - 12 are 0.8, children 7 - 9 are 0.7, children 5 - 7 are 0.6, children 3 - 5 are 0.5, and children 1 - 3 are 0.4 consumption unit (Aykroyd 1963, p. 8). Prior to 1963, however, the scale for adult females and for children 12 - 13 was taken as 0.8 consumption unit, while no coefficient was provided for children under 4 years old. Both the FAO scale and the old League of Nations consumer unit scale give yet other weightings to age and sex. The reader may refer to Farnsworth (1961), McArthur (1964), and Chakravarti (1970) for an introduction to the lively differences of opinion on the whole complicated matter of what assumptions and methodology should be adopted for the best approximation of food availability and nutritional adequacy in reference to large, subsistence-level populations.

Table 4

Average Daily Intakes of Food Items (in Grams)

Items	Actual Diets[1]			Recommended Balanced Diets	
	All-India	Uttar Pradesh	Bihar	"Ideal"[2]	Low-Cost Improved[3]
Cereals	470	606	504	400	400
Pulses	70	91	77	85	85
Milk and milk products	80	48	16	264	170
Meat, fish and eggs	15	11	10	125	28
Leafy vegetables	20	54	36	114	116
Other vegetables	90	96	92	170	85
Fruit and nuts	15	13	12	85	57
Oils and fats	15	18	11	57	28
Sugar and jaggery	20	30	4	57	57

[1]Source: Indian Council of Medical Research. Nutrition Research Laboratories. Diet Atlas of India. 1964.

[2]Source: Indian Council of Medical Research. Results of Diet Surveys in India, 1935-48. These are the standards of intake recommended by the Nutrition Advisory Committee, but are admittedly well beyond the means of the average Indian citizen.

[3]Source: W. R. Aykroyd. The Nutritive Value of Indian Foods and the Planning of Satisfactory Diets. 1963. This is an improved dietary standard believed to be economically feasible and compatible with current Indian food habits and production resources.

While I am unable to translate the intakes described in Table 4 into caloric and other nutritive values, it is clear that Uttar Pradesh and Bihar show some distinctive departures from the all-India pattern, notably in their much reduced consumption of animal products.

As mentioned above, P. V. Sukhatme does not believe the average Indian cereal intake reaches the level shown in Table 4. He has his own breakdown of daily consumption levels, as of about 1964, and using slightly different categories, as follows (the figures for Europe and North America are given for purposes of comparison):

AVERAGE DAILY INTAKES OF FOOD ITEMS AND NUTRIENTS

Item	India	Europe-North America
Cereals	375 g.	328 g.
Starchy roots	30 g.	316 g.
Sugar (*guṛ* equivalent)	45 g.	88 g.
Pulses and nuts	65 g.	16 g.
Fruits and vegetables	80 g.	362 g.
Meat	4 g.	152 g.
Fish	7 g.	34 g.
Eggs	1 g.	33 g.
Milk and milk products[1]	140 g.	573 g.
Fats and oils[1]	11 g.	47 g.
CALORIES	1970	3060
Animal protein	6 g.	44 g.
Total protein	51 g.	90 g.
Fats	27 g.	106 g.
Calcium	446 mg.	1099 mg.
Iron	15 mg.	17 mg.
Vitamin A	1432 I. U.	5555 I. U.
Thiamine	1.3 mg.	2 mg.
Riboflavin	0.6 mg.	2 mg.
Niacin	7 mg.	19 mg.
Ascorbic Acid	26 mg.	116 mg.

(Sukhatme 1965, p. 79)

[1]Butter and ghee are included with "milk and milk products" in the India statistics, but with "fats and oils" in the Europe and North America figures.

LIST OF REFERENCES

Acharya, B. N., Niyogi, S. P., and Patwardhan, V. N. 1942. "The effect of parching on the biological value of the proteins of some cereals and pulses", Indian Journal of Medical Research, Vol. 30, pp. 73-80

Aggarwal, S. C. 1956. The Salt Industry in India. Delhi: Manager of Publications

Agrawal, G. D. and Bansil, P. C. 1969. Economic Problems of Indian Agriculture. Delhi: Vikas Publications

Alzate, H., Gonzalez, H., and Guzman, J. 1969. "Lactose intolerance in South American Indians", American Journal of Clinical Nutrition, Vol. 22, pp. 122-123

Ashby, Lilian Luker. 1937. My India. Boston: Little, Brown and Co.

Aykroyd, W. R. 1963. The Nutritive Value of Indian Foods and the Planning of Satisfactory Diets. New Delhi: Indian Council of Medical Research (6th ed., fully revised by ICMR)

Ayyar, N. P. and Shrivastava, Shakuntala. 1968. "Land use and nutrition in the Bewas Basin, Central India", p. 172 in 21st International Geographical Congress. Abstracts of Papers (Sivaprasad Das Gupta and Teresa Romanowska-Lakshmanan, eds.). New Delhi

Balfour, Edward. 1885. The Cyclopaedia of India and of Eastern and Southern Asia. London: B. Quaritch (3 vols.)

Behura, N. K. 1962. "Meals and food habits in rural India", Bulletin of the Anthropological Survey of India, Vol. 11, pp. 111-138

Bhaishajyaratnavalī (of Shri Govind Das). 1951. Banaras: Caukhamba (Chowkhamba) Press (in Hindi)

Bhaṇḍārī, Shrīcandrarāj "Vishārad". 1951. Vanaushadhi-Candrōday (An Encyclopaedia of Indian Botanys and Herbs). Varanasi: Chowkhamba Sanskrit Series Office (in Hindi)

Bhārgava, Shrīmatī Rukmaṇīdevī. 1958. Pāk-ratnākar. Varanasi: Bhargava Book Depot (in Hindi)

Bhargava's Standard Illustrated Dictionary of the Hindi Language (Hindi-English Edition. 1946. Banaras: Shree Ganga Pustakalaya (5th ed.)

Bolin, T. D. and Davis, A. E. 1969. "Asian lactose intolerance and its relation to intake of lactose", Nature, Vol. 222, pp. 382-383

Burridge, William. 1944. Climate and Labour. Allahabad: Kitabistan

Carstairs, G. Morris. 1955. "Medicine and faith in rural Rajasthan", pp. 107-134 in Health, Culture, and Community (Benjamin D. Paul, ed.). New York: Russell Sage Foundation

Chakravanti, D. W. and Tyagi, N. 1938. "Studies in effects of heat", Indian Journal of Medical Research, Vol. 25, pp. 791-827

Chakravarti, A. K. 1970. "Foodgrain sufficiency patterns in India", Geographical Review, Vol. 60, pp. 208-228

Chatterjee, G. S., Sarkar, D., and Paul, G. 1966. "A preliminary note on the relative variation between different sections of population in the intake of nutrients in rural India", p. 230 in Human Adaptability to Environments and Physical Fitness (M. S. Malhotra, ed.). Madras: Defence Institute of Physiology and Allied Sciences

Chopra, Pran Nath. 1963. Some Aspects of Society and Culture during the Mughal Age (1526-1707). Agra: Shiva Lal Agarwala and Co.

Chopra, R. N. 1933. Indigenous Drugs of India. Calcutta: The Art Press

Chopra, R. N. and Chopra, I. C. 1965. Drug Addiction with Special Reference to India. New Delhi: Council of Scientific and Industrial Research

Consolazio, C. F. and Shapiro, R. 1964. "Energy requirements of men in extreme heat", pp. 121-127 in Environmental Physiology and Psychology in Arid Conditions. Proceedings of the Lucknow Symposium. Paris: UNESCO

Crooke, William. 1888. A Rural and Agricultural Glossary for the North-West Provinces and Oudh. Calcutta

Das Gupta, Satish Chandra. 1945. The Cow in India. Calcutta: Khadi Pratisthan (2 vols.)

Dastur, J. F. 195-. Medicinal Plants of India and Pakistan. Bombay: D. B. Taraporevala Sons and Co.

Davies, W. L. 1940. Indian Indigenous Milk Products. Calcutta: Thacker, Spink and Co.

De, S. and Ray, S. C. 1952. "Studies on the indigenous method of khoa-making", Indian Journal of Dairy Science, Vol. 5, pp. 147-165

Dey, Kanny Lall. 1896. The Indigenous Drugs of India. Calcutta: Thacker, Spink and Co.

Dill, David Bruce. 1938. Life, Heat, and Altitude. Cambridge: Harvard University Press

Dube, Leela. 1956. Diet, Health and Disease in a North Indian Village. Ithaca: Cornell University India Studies Program (unpublished manuscript)

Dutt, P. R. 1962. Rural Health Services in India. New Delhi: Central Health Education Bureau

Dwarkanath, C. S. 1963. Personal communication

Dwivedi, M. P. and Prasad, B. G. 1964. "Epidemiological study of lathyrism in Rewa", Indian Journal of Medical Research, Vol. 52, pp. 81-116

Edman, Marjorie. 1964. "Nutrition and climate", pp. 533-556 in Medical Climatology (Sidney Licht, ed.). New Haven: Elizabeth Licht

Edwardes. Michael. 1969. Everyday Life in Early India. London: B. T. Batsford

Elliot, Sir Henry M. 1869. Memoirs on the History, Folklore and Distribution of the Races of the North Western Provinces of India. London: Trübner and Co.

Epperlein, J. 1964. "Zur frage der zusälzlichen Kochsalzzufuhr bei chronischer Hitzebelastung", Zeitschrift für Tropenmedizin und Parasitologie, Vol. 15, pp. 211-251

Farnsworth, Helen C. 1961. "Defects, uses and abuses of national food supply and consumption data", Food Research Institute Studies, Vol. 2, pp. 179-201

Flatz, C., Saengudom, C., and Sanguanbhokai, T. 1969. "Lactose intolerance in Thailand", Nature, Vol. 221, pp. 758-759

Fox, R. H. 1958. "Heat stress and nutrition", The Nutrition Society Proceedings, Vol. 17, pp. 173-179

Fuchs, Stephen. 1960. The Gond and Bhumia of Eastern Mandla. Bombay: Asia Publishing House

Gangulee, N. 1939. Health and Nutrition in India. London: Faber and Faber

Ghāgh aur Bhaḍḍarī. n.d. (1962?) Patna: Shrī Gãgā Pustak Mandir (in Hindi)

Gopal, Ram. 1959. India of Vedic Kalpasūtras. Delhi: National Publishing House

Govil, K. K., Mitra, D., and Pant, K. C. 1953. "Dietary habits of school boys in Uttar Pradesh", _The Indian Medical Gazette_, Vol. 88, pp. 1-14

Grande, F. 1964. "Nitrogen metabolism and body temperature of man under combined restriction of food and water", pp. 103-114 in _Environmental Physiology and Psychology in Arid Conditions. Proceedings of the Lucknow Symposium_. Paris: UNESCO

Hamdard (Waqf) Laboratories. 1959. _Village Physician_. Delhi (2 vols.)

Hasan, Kwaja Arif. 1961. _Social and Cultural Factors Affecting Health in a Rural Community_. Ph. D. Dissertation, Lucknow University

Hendley, T. Holbein. 1895. _A Medico-topographical Account of Jeypore_. Calcutta: Calcutta Central Press Co.

Huang, S. S. and Bayless, T. M. 1968. "Milk and lactose intolerance in healthy Orientals", _Science_, Vol. 160, pp. 83-84

Hunter, W. W. 1885-1887. _The Imperial Gazetteer of India_. London: Trübner and Co. (14 vols.)

Huntington, Ellsworth. 1945. _Mainsprings of Civilization_. New York: John Wiley and Sons

Husain, Afzal. 1951. "The nutrition problem of the villager", pp. 147-153 in _Developing Village India_. Bombay: Orient Longmans

India. 1961. _Census of India, 1961_

Indian Council of Medical Research. 1951. _Results of Diet Surveys in India, 1935-48_. New Delhi: ICMR (Special Report Series No. 20)

_____. 1952. _Wheat and Wheat Products as Human Food_. New Delhi: ICMR (Special Report Series No. 23)

_____. 1956. _Report of Work Done in Nutrition in States 1954/1955_. New Delhi: ICMR

_____. 1968. _Annual Report for the Year 1967-68_. New Delhi: ICMR

_____. Nutrition Research Laboratories. 1962. _Annual Report for the Period 1st October 1961 to 30th September 1962_. Hyderabad: ICMR/NRL

_________. 1964. _Diet Atlas of India_. Hyderabad: ICMR/NRL (Special Report Series No. 48)

Jayaswal, Hari Prasad. 1948. _A Geographical Study of the Chunar Tahsil, District Mirzapur (U. P.)_. M. A. Thesis, Department of Geography, Banaras Hindu University

Jelliffe, D. B. 1957. "Social culture and nutrition: cultural blocks and protein malnutrition in early childhood in West Bengal", Pediatrics, Vol. 20, pp. 128-138

Johnson, R. E. 1943. Nutritional Standards for Men in Tropical Climates. Cambridge: Harvard University Fatigue Laboratory (Report No. 17)

Johnson, R. E. and Kark, R. M. 1947. "Environment and food intake in man", Science, Vol. 105, pp. 378-379

Johnson, R. E. and Sargent, Frederick II. 1958. "Some quantitative interrelationships among thermal environment, human metabolism and nutrition", The Nutrition Society Proceedings, Vol. 17, pp. 179-186

Johnson, Victor. 1965. Heatstroke in the South African Gold Mines. Seminar presented to the U. S. Army Research Institute of Environmental Medicine, 5 March 1965 (unpublished)

Joshī, Girīshachandra. 1951. Ādarsh Pāk Vidhi. Banaras: Hindi Pustak Agency (in Hindi)

Kark, R. M., Aiton, H. F., Pease, E. D., Bean, W. B., Henderson, C. R., Johnson, R. E., and Richardson, L. M. 1947. "Tropical deterioration and nutrition", Medicine, Vol. 26, pp. 1-40

Kaṭārā, Kusum. 1960. Vyañjan Vithikā. Vārāṇasī: Hindī Pracārak Pustakālaya (in Hindi)

Kaviratna, Avinash Chandra (ed.). 1890-1901. The Charaka Samhita. Calcutta: the editor

Keusch, G. T., Troncale, F. J., Thavaramara, B., Prinyanont, P., Anderson, P. R., and Bhamarapravathi, N. 1969. "Lactase deficiency in Thailand: effect of prolonged lactose feeding", American Journal of Clinical Nutrition, Vol. 22, pp. 638-641

Khare, R. S. 1961. Domestic Sanitation in a North Indian Village. Ph. D. Dissertation, Lucknow University

Khosla, Kanta. 1963. "Food habits in Saidpur", Home Science, Vol. 1, pp. 11-13

King, E. August (Mrs. Robert Moss King). 1884. The Diary of a Civilian's Wife in India, 1877-1882. London: R. Bentley and Son

Ladell, William S. S. 1965. "Water and salt (sodium chloride) intakes", pp. 235-290 in The Physiology of Human Survival (O. G. Edholm and A. L. Bacharach, eds.). London: Academic Press

Lal, S. B. 1945. "Lathyrism in Bihar", The Indian Medical Gazette, Vol. 84, pp. 1-11

Lal Chand. 1963. "Utilisation of milk in rural families of Indore District", Journal of Veterinary and Animal Husbandry Research, Vol. 7, pp. 55-58

Learmonth, A. T. A. 1956. "A map of calories and proteins in poor Indian diets", National Geographical Journal of India, Vol. 2, pp. 211-212

Lukas, J. Anthony. 1965. "Time of trial for Delhi", New York Times, July 17, 1965

McArthur, Margaret. 1964. "Some factors involved in estimating caloric requirements with special reference to persons engaged in agricultural labour in Asian countries", Journal of the Royal Statistical Society, Series A, Vol. 127, pp. 392-408

Mahadevan, Indira. 1961. "Belief systems in food of the Telugu-speaking people of the Telengana region", Indian Journal of Social Work, Vol. 21, pp. 387-396

Malhotra, M. S. 1966. "People of India including primitive tribes--a survey on physiological adaptation, physical fitness, and nutrition", pp. 329-355 in The Biology of Human Adaptability (Paul Baker and J. S. Weiner, eds.). Oxford: Clarendon Press

Marriott, McKim. 1952. "Technological change in overdeveloped rural areas", Economic Development and Cultural Change, Vol. 1, pp. 261-272

Mathrani, K. P. 1970. "India's effort to tackle nutrition problem--integrated policy in 4th plan", India News, Sept. 18, 1970, p. 2

May, Jacques M. 1961. The Ecology of Malnutrition in the Far and Near East. New York: Hafner Publishing Co.

Mazumdar, Bhakat Prasad. 1960. Socio-economic History of Northern India (1030-1194 A. D.). Calcutta: K. L. Mukhopadhyay

Mills, C. A. 1942. Climate Makes the Man. New York: Harper Brothers

Mitchell, H. H. and Edman, Marjorie. 1951. Nutrition and Climatic Stress. Springfield, Ill.: Charles C. Thomas

Mitra, K. 1953. A Supplement to the Results of Diet Surveys in India 1935-48. New Delhi: ICMR (Special Report Series No. 25)

Nadkarni, K. M. 1954. Indian Materia Medica. Bombay: Popular Book Depot (2 vols.) (3d. ed.)

Nagarajan, V. 1968. "Milk", Nutrition, Vol. 2, pp. 25-30

National Council of Applied Economic Research. 1965. Techno-Economic Survey of Uttar Pradesh. New Delhi: NCAER

National Planning Committee. 1948. National Health. Bombay: Vora and Co.

Nicholls, Lucius. 1945. Tropical Nutrition and Dietetics. London: Bailliere, Tindall and Cox

Norman-Walker, John N. 1943. Indian Village Health. Calcutta: Humphrey Milford

Om Prakash. 1961. Food and Drink in Ancient India. Delhi: Munshi Ram Manohar Lal

Opler, M. E. 1963. "The cultural definition of illness in village India", Human Organization, Vol. 22, pp. 32-35

Organ, Troy Wilson. 1970. The Hindu Quest for the Perfection of Man. Athens, Ohio: Ohio University

Pathyāpathya Nirūpan. 1961. Prayāg: Jagannāth Prasād Shukla Vaidya (in Hindi)

Patwardhan, V. N. 1952. Nutrition in India. Bombay: The Indian Journal of Medical Sciences

Pitts, G. C., Consolazio, F. C., and Johnson, R. E. 1944. "Dietary protein and physical fitness in temperate and hot environments", Journal of Nutrition, Vol. 27, pp. 497-508

Planalp, Jack M. 1956. Religious Life and Values in a North Indian Village. Ph. D. Dissertation, Cornell University (University Microfilms No. 56-979)

Prasad, B. G. 1961. "Some common beliefs and customs in relation to health and disease in Uttar Pradesh", The Antiseptic, Vol. 58, pp. 225-238

Prasad, Kedarnath. 1967. The Economics of a Backward Region in a Backward Economy. Calcutta: Scientific Book Agency (2 vols.)

Quenouille, M. H., Boyne, A. W., Fisher, W. B., and Leitch, I. 1951. Statistical Studies of Recorded Energy Expenditure of Man. London: Commonwealth Bureau of Animal Nutrition

Rangappa, K. S. and Achaya, K. T. 1948. The Chemistry and Manufacture of Indian Dairy Products. Bangalore: Bangalore Printing and Publishing Co.

Rao, B. R. H., Klontz, C. E., Rao, P. S. S., Almas, Begum, and Dumm, N. E. 1961. "Nutrition status survey of the rural population in Sholavaram. Seasonal dietary survey", Indian Journal of Medical Research, Vol. 49, pp. 316-329

Rao, K. Visweswara. 1967. "Our diet over a decade", Nutrition, Vol. 1, pp. 2-5

Roberts, Emma. 1837. Scenes and Characteristics of Hindoostan. London: W. H. Allen and Co. (2 vols.)

Rohrlich, Matei. 1960. "Changes in vitamin distribution by conditioning" (abstract). Fifth International Congress on Nutrition, Washington, D. C., September 1-7, 1960 (Abstracts)

Roy, J. K. 1966. "Diet surveys on some aboriginal tribes of India", pp. 195-209 in Human Adaptability to Environments and Physical Fitness (M. S. Malhotra, ed.). Madras: Defence Institute of Physiology and Allied Sciences

Roy, J. K. and Rao, R. K. 1963. "Studies on the seasonal variation of diet of a semi-agricultural community in West Bengal: effect of the recent flood", Bulletin of the Anthropological Survey of India, Vol. 12, pp. 97-107

Saha, P. N., Sita Devi, A., and Rao, M. N. 1963. "Seasonal variation of basal metabolism rate in Indians", Indian Journal of Medical Research, Vol. 51, pp. 153-163

Sen Gupta, J. K. 1966. Personal communication

Sharma, K. N. n.d. (1962?) "Hindu sects and food patterns in North India", pp. 45-58 in Aspects of Religion in Indian Society (L. P. Vidyarthi, ed.). Meerut: Kedar Nath Ram Nath

Shirur, Ranganath J. 1967. "Fruits in our diet", Nutrition, Vol. 1, pp. 21-25

Shukla, Amōl Candra. 1956. Pāk Bhāratī. Delhi: Technical Book Depot (in Hindi)

Shukla, B. D. n.d. (1965?) Agricultural Saving and Investment in Jaunpur District, Uttar Pradesh. Varanasi: Banaras Hindu University, College of Agriculture

Shukla, Shaligram. 1970. Personal communication

Singh, B. B. 1968. "The availability of calories available for food in the villages of Block Baraut of District Meerut", Geographical Observer, Vol. 4, pp. 66-80

Sinha, Rakesh Ranjan. 1967. "The role of rice-beer in the socio-economic and religious life of Korwas in M. P.", *Vanyajati*, Vol. 15, pp. 32-35

Sinha, Surendra Prasad. 1965. *Indian Agriculture*. Allahabad: Kitab Mahal

Sohar, E., Kalz, J., and Adar, R. 1964. "The prevention of voluntary dehydration", pp. 129-135 in *Environmental Physiology and Psychology in Arid Conditions*. *Proceedings of the Lucknow Symposium*. Paris: UNESCO

Srivastava, Danpat Rai. 1969. *The World of Premchand*. Bloomington: Indiana University Press

Streeter, Carroll P. 1969. *A Partnership to Improve Food Production in India*. New York: The Rockefeller Foundation

Swaminathan, M. and Raghavan, R. K. 1966. *Our Food*. Madras: Ganesh and Co. (5th ed.)

Taylor, Carl. 1968. "The health sciences and Indian village culture", pp. 153-161 in *Science and the Human Condition in India and Pakistan* (Ward Morehouse, ed.). New York: The Rockefeller University Press

Ṭhākur, Jyōtirmayī. 1961. *Pāk Vigyān*. Allahabad: Sāhitya Bhavan (in Hindi)

Time. 1970. "Of man and milk", July 13, 1970, p. 59

The Times of India (New Delhi)

Tromp, S. W. 1963. *Medical Biometeorology*. Amsterdam: Elsevier Publishing Co.

Upadhyaya, K. L. 1968. "Position of women in Bhojpuri folklore", *Folklore*, Vol. 9, pp. 243-250

Uttar Pradesh. Department of Economics and Statistics. *Monthly Bulletin of Statistics*

Uttar Pradesh. Directorate of Economics and Statistics. n.d. (1967?) *Urban Wage Rates of Casual Unskilled Labourers in Uttar Pradesh* (Bulletin No. 107)

Wallace, A. W. 1943. "Heat exhaustion", *Military Surgeon*, Vol. 93, pp. 140-146

The Wealth of India. 1962. New Delhi: Council of Scientific and Industrial Research (6 vols.)

Wilson, D. C. and Widdowson, E. M. 1952. A Comparative Nutritional Survey of Various Communities. Indian Medical Research Memoirs, No. 34

Wiser, Charlotte Viall. 1955. "The foods of an Indian village of North India", Annals of the Missouri Botanical Garden, Vol. 42, pp. 303-361

Wyss, V. 1960. "Influence of meal times on workers engaged in heavy labour in heat", Società italiana di biologia sperimentale. Bollettino, Vol. 36, pp. 1182-1184

ADD:

Ali, Ahmed. 1966. Twilight in Delhi. Bombay: Oxford University Press

Sukhatme, Pandurang V. 1965. Feeding India's Growing Millions. New York: Asia Publishing House

V

HEAT INJURIES IN NORTH INDIA

A. The Anglo-Indian Background

An earlier chapter has described the dietary indiscretions of many if not most of the first British commercial settlers to come to India, but something of the quality of medical advice of the time should also be indicated:

> Even in the hottest weather there were eight or nine courses with a wide variety of wines . . . The doctors advised heavy draughts of port in the hot weather as a specific against fever. One doctor recommended plenty of meat to strengthen the blood, but it was appropriate that he suddenly fell dead after eating a hearty dinner of beef! (Kincaid 1938, p. 70)

As late as 1780 the English in India wore talismans against snake bite, treated cholera by applying a red hot iron to the heel, and were advised by a foremost medical authority to use "a bladder dipped in vinegar" for protection from the sun (Spear 1932, p. 101).

Dr. James Lind's authoritative textbook, An Essay on Diseases Incidental to Europeans in Hot Climates (Lind 1788), still reflected a humoral cast, with its separate chapters on directions for "those of a relaxed and bilious habit of body", "those of consumptive and dropsical habits of body", and "those who labour under an habitual flux". The doctors' principal panacea was bleeding, and Dr. Charles A. Gordon, a surgeon writing in India in 1857, noted that he was able to save only one out of 28 victims of "sunstroke" by the following heroic treatment:

> Slight cautery to the nape of the neck, opening of the right temporal artery and while the patient lay unconscious, a powerful jet of water was directed on the head and epigastrium, croton oil being exhibited externally. (Levick 1859, p. 52)

Little children were cupped until they fainted from loss of blood, after which "a ferocious purge was administered" (Kincaid 1938, p. 71). Such leeching was practised in India up to 1844 (Dewar 1922, p. 167), and a book of "homely hints" published in 1922 recommended a little spirits of wine and water applied with a sponge to the back of the head as a treatment of "sunstroke" (Townsend 1922, p. 66).

In an age when the causes of malaria, "agues" and fevers were totally unknown and their prevention and cure sometimes rivaled the sickness as a threat to life,[1] we might wonder how 60% of the Englishmen settled in Calcutta managed to survive a hot season in one year about 1700, rather than why 40% of them were buried (Spear 1932, p. 11).

> It was an accepted thing on sailing voyages to the Indies in the seventeenth century to lose a fourth of the crew through disease. Permanent trading stations and military garrisons everywhere in the Orient suffered similar losses during the hot weather. (Spencer and Thomas 1948, p. 639)

Early in the 19th century the North Indian environment was still so lethal that the wives of British soldiers often engaged themselves to suitors during their husbands' lives, in preparation for expected widowhood (Brown 1948, p. 254). (Of course, for soldiers there were human enemies as well as the natural environmental hazards.) Even a hundred years after this, such virulent episodes as that described by O'Meara could still occur: 80 members of a British regiment died in one night after their water filters had been accidentally filled with cholera-infected sand from the bed of a river (O'Meara 1935, p. 73).

We cannot from this distance easily judge how much of the enormous Anglo-Indian mortality was due to heat effects alone. No doubt it was much less so among the civilian than among the military population, especially the enlisted men, who by hoary if irrational tradition were so long required to live under single-thickness canvas in summer, and who in consequence suffered much from dysentery and heatstroke (Spear 1932, p. 86). Yet, late in the 19th century Mrs. King found that even the British civilians in India who remained on the plains in summer placed their lives in serious jeopardy, at least when forced to travel:

---

[1]A medical textbook on Indian fevers written before the discovery of an anopheline vector of malaria makes interesting reading. It classifies fevers as quotidian, tertian, quartant, remittent, continued remittent, simple continued, enteric, febricula, ardent or thermic, etc. (Fayrer 1882).

> The deaths from heat apoplexy have been many, but that is the case every year. At the great railway stations they have coffins in readiness for the dead bodies which are sure to be found daily in the trains, dead not from sun heat, but from sheer air heat. (King 1884, p. 106)

At this time (mid-August 1878) train guards were under orders to awaken any passengers who appeared to be asleep, for fear they should in reality be dead or dying from "heat apoplexy".

B. Medical Systems in Contemporary India

It is clear that environmental heat throughout history has posed a threat to comfort, health and life on the North Indian plains, producing with varying frequency the whole gamut of heat disorders recognized by modern medicine (see Appendix B). However, the medical practice which is called upon to cope with heat injuries at the village level in North India is a rather different and certainly a much more heterogeneous one than that found in Europe or America. In addition to the familiar Western (allopathic) medicine it includes local folk medical practices of considerable vitality and diversity as well as long-established systems of Ayurveda, Unani or Unani Tibbi, and homeopathy. To these may be added naturopathy, acupuncture, Siddha, and Yoga, if not others. Acupuncture is said to have a foothold in Calcutta (Chatterjee 1967, p. 220). Yoga uses some of the terms found in Ayurveda, but with different meanings and emphasis. It is especially concerned with conditioning or hardening the body to withstand stresses, and pays special attention to cleansing and purifying procedures of the body's various channels (see Kuvalayananda and Vinekar 1968). Siddha is especially strong in the Tamil-speaking parts of South India, but I have no good information on it as a medical practice.[1]

---

[1]Dr. Charles Leslie and Dr. Carl E. Taylor have just informed me that Siddha seems to be an extremely old, pre-Aryan Dravidian medical system, utilizing especially herbs and metallic salts (see Addenda).

Even the Indian holders of M. D. and M. B. B. S. degrees (and indeed others of lesser qualification)[1] who bear the heavy burden of Western medicine in North India often display remarkably eclectic and tolerant approaches to therapy, blending their dietary and other prescriptions with those of the local folk or the indigenous traditions. Certainly those allopaths who fail to adapt their practice to the psycho-cultural milieu of village India are not likely to enjoy a large practice even when they are surrounded by human suffering (G. M. Carstairs 1955; Marriott 1955).

In contemporary India it is not easy to judge the overall roles and influence of Western medicine vis-a-vis indigenous medicine, or of the various systems relative to each other.[2] There is no question that the reputation of Western medicine in India was unfairly damaged both early and often by the hordes of unqualified quacks who claimed to practice "English medicine" in the 19th century. In 1895 R. Carstairs counted 16 such quacks in one village of 2000 people.

> Their way of making money is low fees and long medicine bills. (R. Carstairs 1895, p. 112)

Much of the lack of confidence of villagers with respect to Western medicine--in its institutional aspects, as contrasted with certain specific paraphernalia, such as the stethoscope or the hypodermic

---

[1]"Qualification" as a doctor is also difficult to define. A study of a sample of 49 Primary Health Centers in U. P. in 1963 revealed that only one of the total was staffed by an M. D. (Banerji and Siddhu 1965, p. 789). The remainder had the following degrees in descending order of qualification: Post-graduate Diploma: 6; Graduate: 18; Condensed M. M. M. S.: 7; Post-licentiate Diploma: 3; and Licentiate: 7. The 1961 Census distinguished only two categories, Degree and Diploma, counting 44,000 of the latter and 37,000 of the former in all of India. In U. P. in 1960 there were an average of 4 M. D.'s per 100,000 population, although many of the eastern districts had only half that number (Census of India 1961. Vol. XV. Part IX. Census Atlas of U. P., p. 320). Almost 90% of the medical doctors in U. P. in 1960 were employed in the public sector, and only 10% in the private sector (Ibid. Vol. I. Part II-C (i). Social and Cultural Tables, p. 350).

[2]See the recent articles by Leslie (1963, 1967, 1968, 1969), Brass (1971), and Croizier (1970).

needle--can perhaps be attributed to this history. Yet, in ordinary Indian life today "English medicine" has high prestige. Even in the humblest bazaar town, a drug shop or "medical hall", as its sign usually proclaims, is equipped with a bench and a table to further its angrezī or "English" atmosphere, unlike the other shops with their cloth-covered raised floors (gaddīs), where shoes are forbidden (Fox 1969, p. 55). From the standpoints of official recognition and sponsorship, of status and prestige among the educated elite of the society, and of the quality of existing medical establishments, Western-oriented "scientific" or allopathic medicine has no real rival and is slowly squeezing out its competitors.[1] The Third Five-Year Plan allotted less than 3% of medical expenditures for Ayurveda, although some of the states, including U. P., give it rather more support. Still, for many years the Indian National Congress passed resolutions calling for government support of "Native Indian Medicine", and the Prime Minister still finds it politically rewarding to address the All-India Ayurvedic Congress, as did Mrs. Gandhi at the 46th annual meeting in Patiala in November 1970, when she made the expected remarks that "the indigenous system of medicine contains much of value, and has a role and relevance today" (The Statesman Weekly, Nov. 14, 1970, p. 14).

So far as organization is concerned, the Ayurvedic forces are split between those who look favorably on more extensive hybridization with Western medicine, and the purists who espouse Shuddha Ayurveda. The very word shuddha means "pure", but carries with it all the additional force of religious sanctity. Shuddha Ayurveda began formally with a conference of disgruntled practitioners and sympathizers in Bombay in 1952 (Croizier 1970, p. 285), and has shown striking skill and modernity at least in its organizational and institutional activities. Due to support by key political figures, it dominates the Panel of Ayurveda in the Planning Commission. There is presently a Central Council of Research for Indigenous Systems of Medicine,[2] and a recent notice states that this

---

[1]This very terminology is a major bone of contention, as the Indian advocates of indigenous medicine insist that Western medicine should not be allowed to appropriate the terms "modern" or "scientific", but rather should be described as "allopathic medicine" (Croizier 1970, p. 282).

[2]The Oct. 30, 1970 issue of India News refers to a Central Council for Research in Indian Medicine and Homeopathy. I do not know if this is the same institution under a revised name, or a different one.

group will coordinate the testing of indigenous recipes relevant to family planning (Swastha Hind, July 1970, p. 213).

The Journal of the Indian Medical Association periodically editorializes against the "600,000 quacks" (in which number they include the Ayurvedic *vaidyas*) who are allowed to practise in India, and the official allopathic position was stated in no uncertain terms to the Committee on Indigenous Systems of Medicine:

> . . . the Indian Medical Association is positively of the opinion that all facilities for continuation of teaching in these indigenous systems of medicine should be stopped forthwith in the best interest of the country and its people and the students themselves. (Report of the Committee on Indigenous Systems of Medicine, 1948, Vol. II, p. 448)

The Indian government's policy is to try to upgrade the quality of medical instruction offered in the Ayurvedic colleges, of which there are nearly 100 in the country (Croizier 1970, p. 285). However, these facilities are still very much inferior to the regular or allopathic medical colleges.[1] In fact, many students turn to Ayurvedic schools simply because they are less demanding and less expensive vehicles to the path of medical practice.

> . . . the fact remains that taught in combination with Western medicine Ayurveda tends to be displaced. (Croizier 1970, p. 285)

---

[1]Murray notes that most Ayurvedic hospitals have appointed to their staff a surgeon, a gynecologist, and sometimes a pathologist, in order to handle cases for which even the Ayurvedists recognize they have no good answers (Murray 1967, p. 77). Something of the marvelous schizoid quality of this dimension of traditional India appears in an anecdote related by him. In a famous Ayurvedic college he visited one department, a research laboratory using the most modern and elaborate electronic equipment, including exact timing devices, to detect active ingredients in certain Ayurvedic drugs. But in another part of the institution, indigenous medicines were actually being prepared; and here workers were cutting up plants on the floor, using primitive knives, and boiling them in a cauldron. Asked how they determined the length of cooking time, they replied: "As long as it takes two cow dung pats to burn"! (Ibid., pp. 79-80)

At a special meeting of the Central Council of Health in New Delhi in 1963 the U. P. Health Minister reported that the Ayurvedic medical students were demanding degrees which would be treated as equivalent to the M. B. B. S. The Union Health Minister replied that "such demands could not be considered" (Government of India. Ministry of Health, 1963, p. 109).

If the Indian vaidyas are quacks, they are such in accordance with the definition cited by Leslie ("The quack is the man who continues through time to please his customers but not his colleagues"), and

> . . . it is a fact that the vast majority of Indians still resort to Ayurvedic treatment, along with other forms of therapy. (Leslie 1963, p. 563)

Marriott, refering to a western U. P. village area, is even more emphatic:

> In terms of numbers of patients, amount of expenditure, and frequency of use, patronage of indigenous medicine surpasses that of western medicine one hundredfold. (Marriott 1955, p. 241)

We may contrast these strong statements (neither of which is necessarily inaccurate as stated) with such survey questionnaires as the following. Mann reports that 51.3% of the people in a village 11 miles north of Delhi now claim to consult "qualified doctors" only. The remainder, or slightly less than half, are willing to patronize both folk or traditional practitioners and qualified doctors (Mann 1966-67, p. 357). Again, in the four major cities of India, only 2% of a large middle-class sample (average monthly income: Rs. 1000) admitted to consulting vaidyas or hakīms, although the proportion rose to 9% among the least educated 10% of the group (Indian Institute of Public Opinion, 1947, p. 15). Finally, the Research Programmes Committee of the Planning Commission found that over 86% of a large urban sample (mostly "middle class") in Bombay patronized only allopathic doctors, while the remainder were not averse to "home treatment" or non-allopathic practitioners (Bulsara 1970, p. 112).

Some of the dynamics of Indian villagers' attitudes toward Western medicine, in relation to folk medicine, have recently been discussed by Fonaroff and Fonaroff. They note correctly that

> Folk medicine is believed by its adherents to be the best, most complete and secure way of treating illness. . . . Acceptance of Western drugs comes as a last resort, and there is a different expectation of results. It has been found that while villagers demand immediate results from Western prescriptions, they do not impose this restriction on the assured native treatments. (Fonaroff and Fonaroff 1966, p. 72)

G. M. Carstairs makes the critical point that the Rajasthan villagers among whom he lived ". . . do not, as we tend to do, believe that one can influence the course of events simply by the exercise of a technical skill". Only through Supernatural Force can a cure be effected, the therapy must in a sense be God-sanctified, and both the healer or doctor and the patient must share deep faith in the process and outcome (G. M. Carstairs 1955, p. 116). However, it would be dangerous to accept almost any generalization with regard to Indian health attitudes and behavior, for they are at the same time complex, highly varied, constantly changing, and as often as not ambivalent or self-contradictory. It is a subject worthy of extensive and separate study.

While Western medicine's hostility to Ayurveda is tempered in private medical practice, especially in rural areas, the contempt of such official bodies as the Indian Medical Association is amply reciprocated by the more chauvinistic <u>vaidyas</u>. Hardly any interview with a prominent Ayurvedic professional is free from some self-assured claim to superiority:

> The concepts of psychosomatic medicine, infection, immunity, susceptibility, endocrine metabolism, stress and other similar phenomena are extremely Ayurvedic in nature if not as advanced in their synthetic inter-conceptual wholeness as the Ayurvedic concepts are. (<u>Report of the Shuddha Ayurvedic Education Committee</u>, 1963, p. 9)

On one occasion I saw high-ranking government Ayurvedic officials hoot at a report of some recently-announced new vaccine, claiming that Ayurveda has treated the disease successfully for centuries. (In fact, <u>vaidyas</u> oppose inoculation on principle, holding that it weakens the natural capacity of the body to resist disease, and many refuse to submit to the mass inoculations or vaccinations frequently imposed on travelers to religious fairs and festivals.)[1] Statements of superiority such as the following flow steadily from Ayurvedic pens:

> . . . if Vaidyas be given the facilities to prepare medicines for these diseases [cancers] in accordance with modes indicated in their Shastras, they can well-nigh attempt to cure fifty percent of cases with faith and confidence. (Shastri n.d., p. 23)

> Dysentery, when it attacks a European, generally proves fatal in India. Yet those Europeans who place themselves under Kavirajes [Ayurvedic practitioners] get themselves cured in no time of this formidable disease. (Kaviratna 1890-1901, p. 408n)

> It was not known to western medical men, till recently, that mercury when combined with sulphur as in black sulphide or red sulphide, can never produce mercurialism--a knowledge which is the birthright of all Ayurvedic physicians. (Kaikini 1965, p. 634)[2]

The last-quoted author additionally boasts (p. 639) that ancient books show the omniscience of early Hindu medicine in prescribing fresh liver

---

[1]But this is an intelligentsia's, not a popular, notion. The pathetic eagerness of the sick villagers for an injection when they visit a doctor has often been remarked by those familiar with the rural Indian health scene. Thus, Miss Hobbs quotes a Block Development Center nurse in Bengal: "'The people don't know whether it's penicillin or water. But they are wild about shots; they won't take pills if they can get a shot. It's thought of as magical.'" (Hobbs 1967, p. 82)

[2]This quotation seems to have been lifted almost word for word--and without accreditation--from Sen (1916, p. 12), the only difference being that the earlier statement began: ". . . it is _not yet known_ . . ." (italics mine). Nevertheless (and such is the paradox of so much of the Indian scene, where the backward and the charlatanic are inseparable from the prescient and profound), the substance of this particular assertion now appears to be correct (see the discussion of _makaradhvaj_ below).

to cure anemia.[1] The devoted reader of Indian newspapers will regularly encounter amazing Ayurvedic claims, such as the following item which appeared in the Oct. 17, 1963 Allahabad Leader:

> Rajkot, Oct. 16 (PTI). Mr. Lal Bahadur Shastri, former Union Home Minister, said here today that Ayurved was also a science as it went to the root of a disease.
>
> Mr. Shastri was the chief guest at the conclusion of a five-day dental camp where painless Ayurvedic dental surgery was practised by Vaidya Labh Shankar Shukla on 12,000 patients. He extracted 2,000 teeth.
>
> Mr. Shastri said he was surprised to know that Ayurved also had dental surgery which extracted the strongest tooth with ease without recourse to drugs and other medical paraphernalia.

And the March 29, 1969 issue of the Overseas Hindustan Times (p. 4) bore a brief item fraught with mixed pathos and hope. It stated that the eminent Burmese statesman U Nu was coming to Bombay in order to consult an Ayurvedic physician. His affliction was described as "atrophy of the brain", and the journalist briskly opined: "There is no allopathic cure for it." But this is not an isolated instance--prominent men in India not uncommonly have recourse to heterodox medical treatment.[2] Thus, the biographers of the great textile industrialist, Shri Ram, state:

> He consulted all kinds: Hindu vaids practising ayurveda, Muslim hakims practising the yunani (Greek) system, allopaths, homeopaths, and even quacks with no pretensions to medical knowledge. (K. Singh and Joshi 1968, p. 229)

---

[1]And an old Indian remedy for night-blindness was goat liver, a food now known to be rich in vitamin A (Megaw 1939, p. 212).

[2]An intriguing and yet unexplored area of the sociology of medicine in modern India lies in the large number (judging from my personal experience) of individuals among the educated elite who insist that one or another indigenous practitioner known to them has accomplished true therapeutic miracles--cures beyond the capacity of the best available Western-trained doctors--and after these latter have failed.

No good statistics exist which would allow us to estimate the relative patronage of allopathic and indigenous medicine in India. Government-operated hospitals and dispensaries in Uttar Pradesh and Bihar make annual reports on the number of out-patients and in-patients treated each year,[1] but even the State and Central Ministries of Health do not know what percentage of all morbidities these figures represent, or the proportion of the average patient's total therapy that derives from this reported source. In the village context they are probably still a small minority of the total.

Even the average town or city dweller in North India, walking to the nearest "clinic" or residence where a doctor has his shingle, is as likely (and in chronic or non-traumatic cases, at least, is probably quite as willing) to find a homeopath, a Unani hakīm, or an Ayurvedic vaidya as he is to find an allopath. Only when he is forced to hospitalization is it relatively certain that the North Indian patient will come under the direct diagnosis and treatment of Western medicine.

C. Ayurvedic Concepts and Treatment of Heat Injuries

"Disease nomenclature" in Ayurveda is an entirely different matter from what it is in Western medicine (see Appendix A), but even the basic tenets of Ayurveda affirm that each individual case is unique and that the process of bodily disequilibrium or disease is a dynamic and changing one which cannot be hypostatized by a single term. In addition, there are rival schools and traditions in modern Ayurveda, and major differences in philosophy and terminology going back at least as far as

---

[1]For example, in 1955 a total of 669 dispensaries and hospitals in Bihar reported the treatment of 166,091 indoor patients and 6,223,909 outdoor patients (1,948,559 children, 2,745,689 male adults and 1,529,661 female adults) (Annual Report on Hospitals and Dispensaries in Bihar, 1955, p. 3). Noting the disproportionate sex ratio, one is reminded of Zimmer's observation: ". . . one should not forget that Hindu medicine is concerned primarily with men. Women and female children, according to the prevalent Indian point of view, are of minor importance. Expectant mothers only are excepted, because they may bear male offspring . . ." (Zimmer 1948, pp. 93-94). Chandrasekhar agrees: "As Hindu parents put greater premium on male children, they are apt to treat female children with relative neglect . . ." (Chandrasekhar 1952, p. 37).

Caraka and Sushruta. Thus, if one places before any Ayurvedic exponents a nomenclature in the English language derived from Western medicine, such as that for the heat disorders, with a view to determining the closest equivalents in Ayurveda, he is likely to receive either a patient reprise of the whole Ayurvedic philosophy or else, if he presses for succinct equivalents, almost as many different responses as there are vaidyas present.

"Hotness" and "dryness" in the ambient environment and the seasonal ascendancy of the Sun, both as Cosmic Principle and as physical reality, were recognized by Caraka as external factors predisposing to the morbid increase and diffusion in the body of the humor Pitta.[1] For the most part, therefore, what we define as heat disorders were and are looked upon by Ayurvedic doctors as primarily disorders of Pitta. It will be remembered, however, that each humor has five sub-divisions and a number of attributes which also act in effect as sub-humors. Pitta, in addition to or instead of heat, may be identified by dryness, suppuration, burning sensation, etc. It follows then that what Western medicine sees as a single disease syndrome, in Ayurveda may be given different names, with different types of therapy indicated, depending upon the prominence and type of subjective and objective symptoms manifested by the patient. Further differentiation is based upon the stage of the ailment according to Ayurvedic definition (whether "accumulation", "diffusion", "fermentation", etc.), as well as from the secondary involvement of additional humors and the relative predominance of dōsha or dushya, i.e., the humor or the affected bodily "tissue".

Among the 40 "diseases of Pitta" enumerated by Caraka are atisveda, osha, plosha, trishādhikya, ūshmādhikya, dāha and the variants of dāha: antardāha, angadāha, tvagdāha, mānsadāha, etc. (Caraka Saṃhitā, Sūtra Sthān, Chapter XX). We would be more inclined to describe these as symptoms than as diseases, for atisveda is defined as "a condition of copious or excess perspiration", osha as "a disease in which the patient

[1] In Bhattacharyya's terms (see Appendix A, p. 368), the seasons, like individuals, may be accused of "unnatural" behavior. Too much heat in summer is a form of atiyōga or over-action, while unseasonable heat in winter or cold in summer is mithyayōga, under-action. Any such departure from "natural" seasonal behavior is a potent cause of disease.

experiences the sensation of a fire being always placed very close to his body", plosha as "that disease in which the patient has the sensation of his body being slightly scorched over fire", tr'shādhikya as "a condition of excess of thirst", ūshmādhikya as "a condition of excess of internal heat in the body", and dāha as "a sensation of burning experienced in every part of the body". In antardāha the symptoms are particularly localized in the thorax, in angadāha in the shoulders, in tvagdāha on the skin surface, and in mānsadāha beneath the skin in the flesh (Kaviratna 1890-1901, pp. 226-7n). One of the early English students of Ayurveda spoke of a form of dāha which results "when a foolish person does not drink water when he is thirsty" (Wise 1845, p. 217), but he does not give its Sanskrit name.

Dāha[1] is the disease of Pitta named by Caraka that most closely corresponds to "heat hyperpyrexia", and ūshmādhikya is that corresponding to "heatstroke", according to most vaidyas whom I interviewed. However, some vaidyas prefer to look upon hyperpyrexia as atipitta-prakōpa or "a massive diffusion of Pitta", and essentially prodromal. As Bhishagratna notes,

> The morbific principles or doshas may permeate the whole organism without creating disease. Only when they find a distinct lodgment, centered on some distinct part or tissue of the body, they become exciting factors of disease. (The Sushruta Samhita, Vol. I, p. xlii)

Thus, in the case of heat hyperpyrexia or an accession and diffusion of Pitta, the Ayurvedic treatment consists in reducing Pitta by therapy which enhances its opposites: coolness and moisture.

> Cooling measures or applications should be prescribed or made in the event of any part of the body being scorched by excessive heat, or being exposed to a draught of hot and parched wind. (Ibid., Vol. I, p. 96)

---

[1]In the Vedas, well before the time of Caraka, the word dāha was not used in relation to disease, but rather carried the meaning of "to burn" (in a concrete sense, so as to leave ashes or other physical evidence) (Blair 1961, p. 87).

In the case of heatstroke, it is assumed that the diffused Pitta, not having been successfully counteracted, has vitiated a tissue, usually rasa (chyle), but sometimes rakta (blood).

Undue exposure to the sun is termed ātapa and Sushruta states that this aggravates Pitta but increases the power of digestion (this latter assertion, however, is flatly contradicted by Caraka). Further, it

> . . . agitates the blood and begets thirst, perspiration, faintness (sunstroke), vertigo and a burning sensation in the body attended by a discoloring of the complexion. (The Sushruta Samhita, Vol. I, p. 492)

In general, the Ayurvedic authorities make a distinction between heat injuries resulting from over-exposure to Sun (regarded as very dangerous) and all other conditions of over-heating in the body in which environmental heat may or may not be implicated, which are less likely to be feared, initially at least. The term anshughāt (from anshu, "Sun's rays" and ghāt, "stroke" or "attack") is used by some vaidyas today as an equivalent for what an English-speaking layman would call "sunstroke". But the word is not found in classical Ayurveda and thus is scorned by purists. However, the term suryavedh (literally, "Sun-piercing") is used in a rather similar sense in early Ayurvedic texts, while Sushruta lists āttāpadant (burn caused by hot air and the Sun's rays) among his several kinds of "burns".[1]

The references to the effects of heat on the body in the Caraka Samhita and the Sushruta Samhita always assume that perspiration is increased. The breakdown of the body's evaporative mechanism and the cessation of sweating that are characteristic of an advanced stage of heatstroke do not seem to be recognized in the Ayurvedic classics. This is rather surprising, although it may be explained partly by the fact that the early center of Indo-Aryan settlement in India was in the cooler northwestern region and the Aryans had not sufficiently experienced the torrid climate of the northern plains. In fact, Caraka lived in temperate Kashmir, although he is believed to have traveled

[1]For the most serious of these, the "burn" caused by lightning, Sushruta claimed there is no remedy.

as far afield as present-day Uttar Pradesh.[1] Modern _vaidyas_ are aware of the frequent occurrence of perspiration stoppage in heatstroke, but in Ayurvedic terms this may be regarded as a dangerous bidiscordance involving the humor Vata, which is normally responsible for the expelling of perspiration. Or more often, failure of the body's thermoregulatory system in heatstroke is seen by Ayurveda as the massive enhancement and diffusion of Pitta to such a degree that it "burns up" and dries out the Kapha, represented by watery elements, in the body. In the case of _anshughāt_ or "sunstroke", according to one learned _vaidya_ to whom I talked, there is an increase in Vyana Vata and in Sadhaka Pitta and a decrease in Tarpaka Kapha and Bhrajaka Pitta. The fact that one part of the humor Pitta can be regarded as decreasing while another is increasing points up the complexity and subtlety of distinctions that may be made in the Ayurvedic system.

Bhattacharyya has catalogued some 123 diseases, grouping them according to the involvement of one or more of the three _dōshas_. He includes "heatstroke" (along with such other dysfunctions as amoebic dysentery, dengue fever, hysteria, infantile tetanus, angina pectoris, leukemia, migraine, piles, malaria, and yellow fever) among those conditions where both Pitta and Vata are aroused. Because the fire-like Pitta and the air-like Vata are simultaneously implicated in these sicknesses,

> It is like the burning of a house in the middle of a storm. (Bhattacharyya 1951, p. 24)

Or put another way, since in Vata-Pitta conditions the circulatory and nervous systems are both involved, symptoms change with lightning rapidity, according to Bhattacharyya.

If even the relatively distinctive syndrome of heatstroke has not been clearly identified in Ayurvedic medicine, we certainly could not expect this to be the case with heat exhaustion, with its extreme variability of symptoms (see Appendix B). The _vaidya_ looks upon pain as the action of Vata, while flushing, fever, vomiting, and unconsciousness are the results of Pitta, and chills and paleness derive from Kapha.

---

[1] In addition, the period of classic Ayurvedic development seems to have coincided with a relatively cool period in the earth's climatic history (see Chapter I).

Since Ayurvedic diagnosis is largely symptomatic, therefore, heat exhaustion cases are susceptible of many variations in Ayurvedic etiological explanation and in therapy. However, a Pitta disorder is likely to be diagnosed whenever the collapse or illness is seen to follow immediately upon excessive exertion in or exposure to the sun or the hot dry environment of the summer season (April-June), and whenever the symptoms theoretically associated with Pitta are predominant.

This is less likely to be the case in the hot humid days of July through September, or when the patient succumbs without exposure to the sun, or when fewer of his symptoms are of the kind attributed to Pitta. Thus, muscle cramps point to the involvement of Vata, while a cold and clammy skin, a change in the voice, or the like, following the patient's exposure to some combination of heat and cold (e.g., working under a hot sun with the feet in water, or drinking too much cold water at midday) is frequently indicative of shītāngyasannipāt. Shītāngyasannipāt is that one of the 13 types of sannipāt or tridiscordance in which the patient feels hot but has a cold body. Again, certain cases of what a Western doctor would diagnose as heat exhaustion might be described as rasakshaya ("chyle-vitiation"), wasting of the first of the seven "tissues", the fluid into which digested food is converted according to Ayurvedic theory. Symptoms of rasakshaya are: pain in the chest, irritability, rapid pulse, feeling of heat in the eyes and palms, drowsiness, and faintness. Many heat exhaustion cases would also be diagnosed by vaidyas as svedakshaya, or "vitiation of sweat".

Most of the traditional Ayurvedic preventives against heat injury have been suggested in Chapter II. They specifically include avoidance of exposure to severe sun, heat, or fire, and avoidance of over-work, anger, or promiscuous diet (Caraka Saṃhitā, Nidāna Sthān, Chap. I). In diet, the rasa or "taste" to be emphasized is foremost sweet, followed by astringent and bitter, and the gunas or "qualities" to be sought are shīta ("cold"), mād or manda ("torpid"), etc. In food, ghee or clarified butter especially meets these requirements and is considered a potent subduer of Pitta. The same is true of limes and lemons, so much used in the hot season. Caraka also believed that "predigestion eating"--the consumption of food before the previous meal has been digested--is especially provocative of Pitta.

According to the classic Ayurvedic texts the cure of what we call heat exhaustion and heatstroke and of what in Ayurveda is most often looked upon as a morbid increase of the humor Pitta, follows essentially the same principles as prevention. Various treatments for dāha are described on pp. 359-360 of the Bhaishajyaratnavali of Shri Govind Das. Vaidyas today state that the immediate treatment of choice for a person who collapses or shows severe distress after apparent over-exposure to high heat is physical cooling of the body by water and fanning. Vaidyas do not recommend the use of ice, believing that it has an underlying deleterious "hot" effect, even though it seems cold. Rather, they prescribe the application to the patient's head of a particular oil known as Vishnu Tel. This is made from sesame oil and other "cooling" herbal ingredients. Another oil often applied to the head in cases of heat collapse is castor oil.

The most famous cooling medicament for the head, however, is ghee washed 100 times with water. It is prepared in the following way. A quantity of pure ghee in thin liquid form is poured into a bowl containing water, and stirred well. When it is well mixed a square of clean thick white cloth is put into the bowl, soaking up the ghee and leaving only the water. The ghee is then squeezed from the cloth into another bowl of water and the process is repeated--in theory 100 times, but in actual practice usually only 21 times. After the series of washings the ghee is considerably reduced in amount but its therapeutic effect--in cooling, and also in healing wounds or cuts--is believed to be very great. Ghee is expensive and many villagers use mustard or sesame oil instead; after being "washed" in this manner it is referred to as tēlpaniyā (from tēl, "oil" and pānī, "water").

Since the Ayurvedic pharmacopeia fills volumes, even the repertoire of preparations for external and internal use in allaying Pitta is a lengthy one. And, of course, in any given case with which a vaidya would deal today the exact treatment would in theory vary somewhat depending on such considerations as the individual temperament, the predominance of dōsha or dushya, secondary involvement of another humor, etc. However, some of the most typical tonic or recuperative prescriptions for patients affected by heat stress, following the initial step of physical cooling of the body, include fluid drinks, sandalwood, pearls, and the like. Thus, one vaidya recommends the combination of makaradhvaj[1] and sandalwood, ground with honey and

[1]See the description of makaradhvaj in Appendix A.

mixed with water.[1] Another prescribes pearl oxide and makaradhvaj in equal amounts, ground in honey and applied to the gums. Or pearl oxide is mixed with rose water, pulverized, and taken as a tonic to "cool the brain". Curative drinks include sugar cane juice, sharbats made from such plants as sandalwood, khas, and banana root, and decoctions of ã̃valā (Phyllanthus emblica, or "Indian gooseberry"), coriander seeds, etc. Certain kinds of leaves considered exceptionally cooling are brought into proximity to the patient; that is, he is rubbed with them or he is made to lie on a bed of them. These "cold" leaves are usually neem, lotus (Nelumbrium speciosum),[2] and banana. The main Ayurvedic external applications in cases of acute heat injury are massaging of the limbs and body with various substances. Govind Das, for example, in the Bhaishajyaratnavali mentions ghee washed 100 times, barley sattū, ground kernels of jujube (Zizyphus jujuba), and ã̃valā pulp, while Wise speaks of clothes wetted in fermenting rice water and sandalwood paste mixed with khas roots (Wise 1845, p. 217).

Pandit Shukla, in his modern Hindi version of the Pathyapathyam (Pathyāpathya Nirūpaṇ, 1961, p. 31), lists a bewildering array of foods (and behavior) which he considers to be helpful in cases of "disorders due to dāha (dāharōg). There are too many to list here, but some prominence is given to old grains (those harvested two or three years ago), such as boiled rice or boiled kōdõ, and capātīs of old barley or wheat. Other recommendations are applications of oil, walking in cool orchards and on the banks of bodies of water, listening to soothing religious discourse and song, and sleeping in the moonlight. Specifically proscribed are such diverse items as sexual intercourse, angry emotions, pān or betel, carrots, mustard, coconut juice, rock salt, butter made from buffalo milk, certain types of sweets, foods made from white flour, and in general anything which is provocative of Pitta.

---

[1] Note the implementation here of the Ayurvedic principle that anupāna, the vehicle or medium of suspension of a medicine, must be opposite in qualities to the medicine for which it is a vehicle. Honey in itself is one of the few substances of "sweet" rasa that is considered "hot" rather than "cold", and indeed it is so incompatible with heat that Caraka warns that the ingesting of honey which is heated, or of honey by one who is afflicted by heat, will result in death. Nevertheless, it is the proper anupāna for use with "cooling" medicines.

[2] A sharbat made from lotus is also used as a refrigerant in the folk medical treatment of smallpox (Kirtikar and Basu 1918, p. 75).

Modern vaidyas admit that they seldom see cases of heat exhaustion and heatstroke at an early stage. First, heat exhaustion appears to be relatively uncommon in North India. Secondly, the symptoms of heat hyperpyrexia are so well known to most people and the urgency of immediate treatment is so fully appreciated that cooling measures are initiated at once by family members, co-workers or friends. In cities or in proximity to a hospital, seriously-affected heatstroke victims are generally taken directly to the hospital, although less severe cases are simply treated at home. A vaidya is most likely to be consulted in rural areas and at a later stage of heat injury, when there may be complications or a poor recovery.

It may be of some importance to note that, while preference and respect for "Western" or allopathic doctors are undoubtedly increasing at the expense of folk and indigenous practitioners, most of the drugs and medicines supplied by allopathy are popularly regarded as "heating" or "hot" in effect, in terms of the dominant ideology (Dhillon 1965). One could theorize that, for this reason, allopathic medical treatment might be less enthusiastically sought in the hot season, or in the case of heat-related disorders. However, I have no real evidence that this is actually the case.

It is Ayurvedic dogma that whatever an ill person craves to eat or drink should be provided him, as any such desire represents a kind of "wisdom of the body" which should be satisfied. Anyone affected by excessive heat who feels thirst is allowed to drink fluids ad libitum, and in fact fluids are likely to be pressed upon him.

While the depletion of body fluids as a concomitant or even as a cause of heat injury is implied if not clearly stated in the classic Ayurvedic texts, there is no indication that the specific role of salt balance in relation to heat exhaustion was recognized. Caraka counseled the use of salt in the rainy season and especially in the winter, but strictly warned against over-indulgence in the autumn and, most of all, in the hot summer. In excess the saline rasa is believed to provoke both Pitta and--along with the sweet and sour "tastes"--Kapha. It is compatible with and curative only of Vata.

> Used in excess, it causes depression, flabbiness and debility in the body. Those communities which are given to over use of salt, whether they are country people, city dwellers or itinerants, become languid, flabby and anemic and are unable to bear hardships. (The Charaka Samhita, Vol. V, p. 281)

In keeping with these views, salt has the properties of "heat" and "acuteness" in the classic Ayurvedic system. It is interesting to note, however, that a modern Hindi encyclopedia of medicinal plants and substances describes salt as <u>halkā</u> ("light"), <u>snigdha</u> ("viscous, oily"), and <u>shītal</u> ("cold"), in precise contrast to the earlier Ayurvedic view (Bhandari 1951, Vol. 5, p. 1003). Certainly in the popular or layman's view salt is a "cold" food.

D. Popular Concepts and Treatment of Heat Injuries

Although folk medical practice in North India is a richly varied subject with relevance for many current concerns of social, behavioral, and medical science, it has only recently begun to receive systematic study. The villager's ideas and classifications of illness generally follow the inspiration of Ayurvedic theory, with many local modifications. In fact, probably no clear line of distinction can be drawn between the popular or folk medical ideas in North India and the Ayurvedic system.[1] This is a part of traditional Brahmanical culture and there is scarcely a Hindu village of any size in North India in which may not be found at least one or two learned Brahmans who have an acquaintance with Ayurveda. These men tend to serve as custodians of tradition and as reference points of ritual-therapeutic authority in a village, even if they are not full-time Ayurvedic practitioners. Many of them do in fact act as <u>vaidyas</u> in a small way or as a sideline. Thus, even the average unlettered village laborer, peasant, or craftsman has a world view and an orientation toward health and disease that is largely derived from the Brahmanical Ayurvedic fount.

---

[1]The <u>materia medica</u> of India, utilized enormously by Ayurvedic medicine, Unani medicine, and folk medicine alike--and even by allopathy and homeopathy--has been described in considerable detail in a number of encyclopedias and pharmacopeias, such as Dutt 1877, Chopra 1933, Dastur 195-, and Nadkarni 1954. Dozens of other sources are cited in Bhandari (1951) and the <u>Cikitsā-Sāhitya</u> or Medical Catalogue of Chowkhamba Press, in Varanasi. For accounts of actual, down-to-earth folk medical treatments of many types of the physical ills afflicting mankind in India, by the means of almost 400 different medicinal plants and substances, see <u>The Village Physician</u> (Hamdard 1959).

In the Varanasi area of eastern U. P., villagers think of the three Ayurvedic <u>dōshas</u> in a rather crude fashion: Pitta (Bhoj. <u>pitt</u>) as a liquid; Kapha (Bhoj. <u>kaf</u>) as phlegm, mucus or other thick discharge; and Vata (Bhoj. <u>bāī</u>) as flatulence, associated with rheumatism. In fact, the Hindi term <u>vāta</u> (Bhoj. <u>bāt</u>) is now the village word for rheumatism. The word <u>dhātu</u>, technically referring in Ayurveda to a "tissue", has a distorted or corrupt village meaning, generally being applied in reference to some abnormality in urinary or other excretions. If, for example, there is a white film on the urine, people will say "the <u>dhātu</u> is going out". Eastern U. P. villagers use the term <u>dvandaj</u>, rather than the correct Ayurvedic word <u>sansarg</u>, to refer to a condition of bidiscordance of humors. The word <u>sannipāt</u>, which in Ayurveda means tridiscordance of humors, simply implies to the average person that the patient is near death.

A noteworthy exposition of village concepts of health and sickness, referring specifically to a village near Lucknow, has been made by K. A. Hasan. One of his interesting observations--a surprising one in view of the amount of sickness in village India--is that when people sit together and talk or gossip, health is hardly ever a subject of conversation.[1] At any rate, villagers do not display great anxiety about the matter, for disease is generally regarded as beyond human control, and health is a matter of chance or fate. There is a deep belief that every being and person has his allotted span; many old people take pride in never having consulted a doctor (Hasan 1961, p. 204).

Many kinds of ailments, such as amoebic and helminthic infestations, are simply not known or diagnosed by people. Indeed, Hasan found that, out of 80 villagers queried, the only one who knew of germs was a high school student of 19 (<u>Ibid</u>., p. 60). These villagers believed, for example, that potassium permanganate was put into wells, not to reduce bacterial pathogens, but to exterminate insects. A large proportion of sicknesses in North Indian villages are attributed to supernatural

---

[1]This is a finding which some other experienced observers of the Indian village scene dispute. Thus, Gangulee says: "In Indian homes, rich and poor, the complaints of suffering from undefinable illnesses are almost universal . . ." (Gangulee 1939, p. 133). And Carl Taylor claims that ". . . there are few matters of which village people think and talk more than about how they feel" (Taylor 1968, p. 153).

causes: breach of taboo, spirit and ghost intrusion, sorcery and evil eye, and the wrathful action of gods and goddesses (Hasan 1961, pp. 208ff). Equally important, in village eyes, are certain "physical" causes of illness, involving humoral derangements in the body, improper diet, "impure blood", "unclean stomach", the effects of "heat" and "cold", etc. Colds, diarrhea, boils, skin afflictions, and many fevers are generally attributed to these causes, and Hasan has described a number of these associations of cause and effect (Ibid., p. 232). Elsewhere, the present author has described some of the great range of exorcists and supernatural curers in an Indian village (Planalp 1956, pp. 636ff), and G. M. Carstairs (1955), Marriott (1955), Hasan (1961), R. S. Mann (1966-67), and others have provided comparable lists.

1. Folk Definition and Description of Heat Injuries

The principal heat disorder recognized throughout North India is lū lagnā or "hot wind stroke". Lū is the name given to the local, thermally originated, convectional west wind that blows at midday during the summer season, from April into June. The word lū is derived from the Sanskrit lava, meaning "flame" (Shukla 1970). Possibly the New York Times correspondent in New Delhi knew this, but more probably his fortuitous choice of metaphors in describing the lū illustrates why this word was long ago adopted by North Indians:

> Some time in March, suddenly you are walking along the street, enjoying a sort of semi-tropical spring, when the merest breath of overheated air touches your skin like a fleeting tongue of flame. This is the first flicker of the loo, the terrible, dust-laden hot wind that will soon turn the North Indian plains into a parched inferno for most of April, May and June. (Trumbull 1957, p. 12)

So far as I can determine, the word lū is not found in Ayurvedic texts. However, Ayurveda does attribute important and distinct effects to wind directions. Thus, the north wind increases Kapha and increases strength; the south wind is light and sedative, and curative of blood and Pitta disorders. The east wind increases Kapha diseases but removes derangements of Vata, while the west wind--and this is descriptive of lū--increases internal heat, dries up the Kapha and fat in the body, and decreases strength (Wise 1845, p. 89).[1]

The average villager knows and respects the force of the scorching heat and the blazing sun, but he especially fears the effect of the lū and attributes to it most cases of acute heat injury.[2] The awe with which the lū is regarded is apparent when a Camar points to the bamboo clump near his hut and says: "During the summer the lū turns the west side of those bamboos completely brown". In fact, supernatural danger is clearly felt to lurk in the vortex of the dust-devils or bavaṇḍars which accompany the lū, and the village mother unconsciously conveys her fear to her children as she summons them from their whirling path. Village women say that the havā kā gherā or "circle of wind" harbors a "god" or supernatural force.

Psychological stresses in Indian villages are indicated by the frequency of what are defined as attacks and possession by "ghosts" or supernatural beings. It is significant that these usually occur mostly at night, when paths and fields are deserted of people. By the same token, however, they may also take place at midday in summer, for at this time too paths and streets are almost deserted.

> . . . the deadly wind, loo, makes it impossible to walk along roads in the afternoon hours. (Prasad 1968, p. 351)

---

[1]There is a considerable European biometeorological literature dealing with the various "winds of ill repute" around the world--the Santa Ana, Chinook, Sirocco, Chamsin, Foehn, Mistral, etc. One of the most sophisticated of recent studies of the medical effects of a hot dry desert wind--the Sharav in Israel--has been reported by Danon, Weller, and Sulman (1969). In a clinical study of 100 weather-sensitive patients they distinguished at least four different syndromes of reaction: (1) catecholamine deficiency (exhaustion syndrome); (2) serotonin hyperfunction (irritation syndrome); (3) adrenal cortical dysfunction; and (4) sweating syndrome.

[2]The early British in India also spoke of an "apoplexy of the hot winds" (Gordon 1857, p. 417).

Willcox has graphically described the summer days in Iraq, where the Arabs traditionally build their houses with very thick mud walls and roofs, leaving little window space, all designed to keep out the hot air rather than to ventilate (Willcox 1920, p. 393). He notes that, especially on those days when temperatures reach or exceed 120° F., the onset of any wind is greatly feared, and people who are outdoors immediately take shelter. The conditions during the summer are frequently no less severe in North India than in Iraq, and Indian villagers have also long cloistered themselves within the insulation of thick mud walls during the hottest part of the day. John Marshall observed this even in humid Bengal in the 17th century:

> People keep all within and shut oll dores and windowes that noe hot wind come in, and some goe into sellers . . . (Marshall 1668-1672)

Today a little more movement may be visible on roadways than in the past, especially in cities, but for the most part North India seems to lie almost inert and lifeless at midday during heat waves in May and June.

In any event, the lū is lethal enough without benefit of supernatural overtones. The similar hot dusty simoom wind of Southwest Asia is called "poison wind" because its sudden onset can cause heatstroke (Huschke 1959, p. 511), and four and a half centuries ago the first Mughal king, Babur, described just such a condition in North India in his memoirs:

> It happened too that the heats were this year uncommonly oppressive. Many men about the same time dropped down, as if they had been affected by the Simūm wind, and died on the spot. (Bābur-Nāma, p. 191)

Something of the capacity of the lū for adding to discomfort and psychological distress as well as being a threat to health is indicated in a graphic description by a modern visitor:

> Bihar has the worst extremes of Indian climate. It suffers under a wind which comes hot and blistering off the Rajasthan desert. People have been known to choke to death in it. It blasts you with dust and sand. Whether you walk or drive, the dust is in your nose, your ears, inside your clothes, filming on your skin. The thick, gray haze on the horizon is not cloud, but dust. (Hopcraft 1968, p. 120)

During May and June on the North Indian plains there are midday wind speeds of 20 miles per hour on more than one day in three, and on a few days every summer the lū gusts to over 40 miles per hour (Sinha 1952, p. 101).

> The adverse effect of hot winds in a desert area is shown by the observation that at 128° F. it is not possible to survive long in a wind of 20 miles per hour, whereas if the wind increases to 58 miles per hour long survival would not be possible even at 117° F. (Napier 1943, p. 36)

For brief periods these conditions are closely approached in the North Indian summer. The *Indian Nation* (Patna) of June 12, 1966 described the case of a man working in 120° F. temperature along the Grand Trunk Road near Dhanbad. When a sudden hot blast of wind caught him, along with his wife and child, they all simultaneously fell unconscious, according to this account.

Popular descriptions of the symptoms of *lū lagnā* vary considerably depending upon the informant, but there is agreement that it usually occurs after an individual has been outdoors (generally, exposed to direct sun as well as to the hot wind) in the hot dry season. Some of the most frequently mentioned symptoms of *lū lagnā* are the following: thirst, fever, feeling of heat in the body, headache, restlessness or delirium, and darkening or blackening of the skin. The victim may also faint or collapse. Informants believe that a large proportion of *lū lagnā* cases are fatal and thus look upon it as a very serious matter. But if a person who has been exposed to solar radiation--and even to the *lū* wind as well--suffers what appears to be a mild case of hyperpyrexia or other heat effects, from which an early and good recovery is made, villagers will tend to refer subsequently to this not as *lū lagnā*, but as *ghām lagnā* or (especially in western U. P.) the synonym *dhūp lagnā*.[1]

---

[1] I am indebted to Shaligram Shukla for pointing out that the word *ghām* is derived from Sanskrit *gharmas*, which is a cognate of the Greek θέρμος. The primary meaning of *gharmas* was "heat", and the secondary meaning was "sunshine". But in popular Hindi and Bhojpuri usage today *ghām* means "sunshine" or "sun's heat"--the word may be applied in winter as well as in summer (Shukla 1970).

It is obvious that "lū lagnā" is a popular or lay term with little medical precision, which villagers generally apply to most cases of classic heatstroke and probably to a variety of other heat disorders (heat hyperpyrexia, heat syncope, and some cases of heat exhaustion) and sometimes even to conditions such as cerebral malaria which are difficult to distinguish from heatstroke without laboratory tests.

Two different Ayurvedic vaidyas who are fairly well-read in Western medicine offered me the emphatic opinion that lū lagnā is qualitatively different from heatstroke in its etiology and its effects on the body. One vaidya claimed that the lū conveys some peculiar effects which he compared to electric shock--an "electronic web" is the English phrase he used. He asserted that in lū lagnā the sensory nerve endings are "burned" or shattered immediately. Another vaidya contrasted lū lagnā with heatstroke, claiming that in heatstroke the victim does not lose consciousness, has a rapid pulse, and that after death the body becomes quite dark. He claimed the opposite to be the case in lū lagnā.

Almost by definition, nearly everyone interviewed by me denied that lū lagnā ever occurs in the sultry monsoon season of July to September, when prevailing winds are easterly and the dry westerly lū wind does not blow. Nevertheless, on Sept. 26, 1966, a Hindi-language daily newspaper in Patna, Bihar, reported as follows under the headline "Lū sē ēk Vyakti kī Mrityu (Death of a Person from Lū)":

> Last Wednesday in village Batohar in western Barahiya Taluk a man died as a result of extreme heat. According to reports, while he was engaged in plowing a field he became very thirsty and walked a short distance to a river to get some water. But upon arriving he could not even drink, as he fell unconscious there and later died. (translated from Pradīp, Sept. 26, 1966, p. 3)

When I asked people about the possibility of acute collapse, illness or death as a result of heat stress where the lū wind is not obviously a factor (e.g., inside a building or during the monsoon months), a few simply denied that such cases occur. Others suggested that this illness is also called lū lagnā. But a majority of informants reckoned that, if heat injury results from exposure to the sun's rays during the sultry season, it is referred to as ghām lagnā. If it occurs inside a building or in a shaded place it may be called garmī lagnā (garmī = "heat").

But informants believe that these kinds of heat injury are much less likely to be serious or fatal than is lū lagnā.

However little unanimity of opinion there may be between one individual and another in North India as to the precise symptoms and definition of lū lagnā, the syndrome is crystal-clear by comparison with most of the other disorders believed by villagers to be heat-caused or heat-related. There is, in fact, a general tendency to attribute all the fevers and epidemics which prevail in the summer--smallpox, typhoid, cholera, gastro-enteritis, malaria, boils and skin infections, etc.--to the effect of "heat", especially as this metaphysical entity isabnormally increased in the body during the hot season. This conceptual association of heat and illness was clearly present in the Delhi area, studied by Lewis and his colleagues:

> ". . . in August and September, if a man works too hard or exposes himself to the heat of the sun for too long, he may get this fever [malaria]." (Lewis 1958, p. 267)
>
> One Jat said that children get smallpox when their mothers have worked in the fields and have become overheated. If the women suckle their children after exposure to the sun, the milk is too warm and the children may get sick. This was also given as an explanation for various other ailments, including diarrhea. (Ibid., p. 269)
>
> ". . . I think that if a man works hard in the sun, he accumulates heat in the body which comes out in typhoid and in the eruptions on the chest." (Ibid., p. 276)

A table of monthly deviations from the annual average of registered deaths for the years 1951-1960 in Uttar Pradesh shows that the highest incidence of deaths occurs in June and in August-September, and the lowest is in January-February:[1]

---

[1]This seasonal pattern of deaths in U. P. may be compared with that of births (see Table 3 above). The registered death rate of about 10 per 1000 population compares with a true annual death rate, based on the National Sample Survey, of 29.8 per 1000, indicating that under-registration of deaths rivals that of births (National Council of Applied Economic Research, 1965, p. 237).

Table 5. Average monthly deviations from average annual rate of registered deaths in Uttar Pradesh, 1951-1960

Month	Rural	Urban
January	- 10.20%	- 11.88%
February	- 7.21%	- 16.64%
March	- 5.21%	- 16.46%
April	- .63%	- 4.17%
May	+ 4.05%	+ 8.98%
June	+ 11.90%	+ 14.10%
July	+ 1.29%	+ 2.36%
August	+ 4.84%	+ 12.01%
September	+ 8.83%	+ 12.56%
October	- 2.51%	+ 1.27%
November	- 2.06%	+ 1.65%
December	- 3.18%	- 4.34%

Source: India. Ministry of Health. Health Statistics of India. (Calculations of percentage deviations were made by the author).

"Fevers including malaria", the category accounting for 66.67% or exactly two-thirds of the registered deaths in U. P. in 1951-60, were highest in June (+ 10.54%) and in August-October (+ 6.19%), and the relative pre-eminence of June in "fever" mortality increased with the steady fall between 1951 and 1960 in registered deaths from malaria alone. (Malaria occurs chiefly in the August-October period, and the number of registered deaths in U. P. attributed to malaria declined from 195,000 in 1951 to 36,000 in 1960). Smallpox (17,090 per year) and cholera (7766 per year) together accounted for 4% of the registered deaths in U. P. in the 1951-60 decade, and in both cases the peak incidence occurred in May and June (Murty 1961, p. 55; Prasad 1961, p. 68). I am unable to provide comparable monthly morbidity figures for North India, but medical authorities in the area stated in interviews that the seasonal flux of non-fatal illnesses is even more pronounced than that of mortalities, which is 22% in rural and 29% in urban areas.

Regardless of allopathic or modern medical diagnosis, villagers tend to explain most ailments occurring during the hot weather as due to "too much heat in the body". This idea of a psycho-physiological or metabolic "overheating" is very widely held and has an Ayurvedic flavor or inspiration. Among men it is definitely associated with genito-urinary abnormalities or manifestations--burning micturition, milky urine, nocturnal emissions, venereal infection, "watery semen", etc. A passage from a modern Ayurvedic English-language advertisement for "Brake pills with gold, king of tonics" is illustrative. The text is quoted verbatim:

> On account of overheat in the body, and of ill effects in the organ resulted in too much indulgence in sexual intercourse, and of other diseases created by illegal means such as self-pushing,etc. the seminal fluid becomes thin and is subject to discharge in dreams at nights and in the long run these discharges will convert into gonorrhea and there by it gives room for loss of manhood, impotency and weakness. (The All India Ayurvedic Directory,1937, p. 4)

Village or folk terminology recognizes a variety of primarily summertime disorders which are "heat"-related in conceptual etiology if not in scientific fact. As noted before, the villager does not think in terms of viruses and germs, but rather turns for causal explanations to such disturbances in the fragile equilibrium of psychosomatic health and harmony as those which result from breach of taboo, supernatural intrusion, and the combination of dietary improprieties (more so than dietary inadequacies) with the external environmental threats of excessive wind, sun, heat, cold, rain, dew, etc. Any inventory of dysfunctions attributed wholly or in part to environmental heat will vary depending upon the region and the informant, but the following list enjoys fairly wide currency in eastern U. P.

Sampāt. This word is derived from the Ayurvedic sannipāt or tridiscordance of humors. But ordinary people use it to describe a condition of heat hyperpyrexia in which the body feels burning hot and the individual becomes restless or even delirious. Where the symptom of delirium is prominent, sampāt is usually first treated by magic, by a local expert in the simple exorcism known as jhār phũk ("sweeping and blowing").[1]

Santāp. Santāp is the Ayurvedic symptomatic word for heat or high temperature in the body. By itself it does not describe any particular disorder. Many villagers use it as a synonym for sampāt, however. (Such metathesis, or transposition of consonants, as in santāp and sampāt, is a characteristic Indo-Aryan linguistic feature.)

Cakkar ānā or Dimāg mẽ garmī. Cakkar ānā ("dizziness") or dimāg mẽ garmī ("heat in the brain") appear to correspond closely to heat syncope as recognized in Western medicine.

Dāh. The word dāh or dāha also derives from Ayurveda (see above). It is used by villagers today to describe those cases of heat distress (probably including heat hyperpyrexia and possibly heatstroke) in which the patient feels a burning sensation or excessive heat, usually following a long period of work in hot conditions, and where he appears to be dehydrated and has not consumed sufficient liquid. However, dāh is also said to be caused sometimes by the effects of alcoholic drinks or by head injuries.

Pitt or Pitta. Pitta, one of the three humors in Ayurveda, is sometimes used by unlettered village people as the name of a disease marked by loss of appetite, by burning in the stomach, and by deep yellow-colored stools and vomiting of yellowish liquid. It is treated by the administration of "cold" foods, especially sharbat or fruit ade made from wood-apple (bēl). Sweetened water in which the leaves of parval or parorā (Trichosanthes dioica) have been soaked overnight is another curative drink.

[1] It is interesting to note that many of the cases which Shepherd described as "subacute heat effect" among Indian troops in Iraq were admitted first as mental patients, and in some cases behavior was maniacal. He states, without further elaboration: "This was frequently noticed in India" (Shepherd 1945, p. 4n).

Tãus. The symptoms of this ailment seem to be those of heat hyperpyrexia, but its distinctive characteristic is an acute and unslakable thirst. *Tãus* develops from working in the heat and the patient has a burning sensation in his whole body and upon urination. Villagers say that a wet cloth put on a person suffering from *tãus* becomes dry in a minute or two due to the high fever.

Shītāng *Shītāng*, from the Ayurvedic *shītangyasannipāt*, is always believed to be an effect of a combination of heat and cold.[1] It is feared in spring, when the sun's heat contrasts with the cool season. Or it may result from sleeping exposed to the heavy dew in August and September or from taking a bath immediately after working in high heat.

> . . . the commencement of the summer season (i.e., February) and the termination of the precipitation period are marked by wide range of temperature. This characteristic is responsible at least to some extent for giving birth to malarious fevers at such times, when people sleep in open without any protection from the chilly effects. (Jayaswal 1948, p. 34)[2]

Shītāng may even result from electric shock. The symptoms described by different informants are so variable that *shītāng* is obviously not a single clinical entity. They are said to include some combination of the following: thirst, restlessness, dizziness, collapse or fainting, fever, pain in the body, panting, perspiration, cold hands and feet, headache, runny nose, and weak pulse. It is probable that some cases of heat exhaustion may be diagnosed by villagers as *shītāng*. The treatment is described below.

---

[1] I understand that the terms *sītgarm* ("cold-heat") and *sītjar* ("cold-fever") are used in the Aligarh area of western U. P. to refer to some kinds of illness attributed to simultaneous or abruptly successive exposure to heat and cold. In eastern U. P., however, if the word *sītgarm* is used it refers to the condition or the situation from exposure to which the sickness called *shītāng* may develop.

[2] It is probably no coincidence that in a total of nearly 4 years spent in North India, the only two occasions when I was stricken by a "fever of unknown origin" were both in September. As Burridge states, ". . . local physicians have been known to declare that everybody catches something in Lucknow during September" (Burridge 1944, p. 83).

Garmi. Garmi or "heat" is the village euphemism for venereal disease or more specifically gonorrhea. However, garmi is also said by some informants to be a disorder resulting from working too hard in excessive heat in the hot dry season. The principal symptom is a burning sensation while urinating, known as cinak. It is not clear which reference of the term is antecedent (gonorrhea is believed to produce great heat in the system). A popular treatment of garmī is a sharbat made from the leaves of canā (Bengal gram), picked in the winter and dried for such purposes as this.

Garmī kī gilti. Swellings under the arms and in the neck are attributed to "excessive heat in the system". The condition is taken as a serious omen demanding early treatment. Otherwise a high fever results and the swellings "go deep into the stomach". Treatment is by grinding the seeds of a plant of unknown species locally referred to as jahar mār ("poison killer") with water into a fine paste and plastering it on the affected places. An old home remedy is to tie a living frog with a thick bandage on the underarm or neck of the patient. It is believed that the jumping movements of the frog, together with some special acidic quality of its skin, help to reduce the swellings.

Amhaurī. Amhaurī or prickly heat is somewhat more associated with the hot humid season than with the hot dry season, although in many years it no doubt reaches a peak during the two weeks just preceding the arrival of the monsoon in June. North Indian villagers do not consider prickly heat to be any more a heat disorder per se than boils or other skin eruptions commonly appearing between April and October.

Dānā. It is not clear if this is a variant of prickly heat or if it constitutes a distinct medical entity, in allopathic terms. The word means "a grain of cereal", and is so called because the small pustules which erupt resemble small grains. At any rate, the dysfunction is said to afflict principally those women who must work near the cooking fire on hot sultry days when there is no wind, and is believed to be elicited especially if they wet their sāṛīs for coolness or if they wet their clothes and bedsheet during hot summer nights for the same reason.

Phunsī-phorī. These two words, singly or in combination, are very general terms applied by villagers to boils and other pustular eruptions of uncertain etiology, but which they generally attribute to an excess of heat in the body, largely as a result of the outside temperature.

However, impure drinking water, excess of "sweetness" in the blood, and so forth may also be cited as causes. One type of large deep-rooted boil called jahar bād or nasūr is attributed to heat and impure blood.

Dādu. Ringworm or dādu is recognized by some people as a contagious infection that may occur at any time of the year. Many others, however, believe it is a hot-season affliction, beginning as a skin irritation which progresses into small white boils when rubbed. Dādu is treated by the external application of a copper coin, since this metal is believed to be especially effective for dādu. Other treatments are the application of cowdung cake, of a paste made from sulphur and coconut oil, or of ground garlic (this last is a rather painful treatment).

Kalkal. Kalkal is described as a skin eruption on the palms and fingers, believed to result from excessive heat. It is externally treated by neem bark ground and mixed with sesame or coconut oil, or by a sulphur-coconut paste, and by internal administration of neem oil.

Eye disorders. Eye diseases are extremely common in North India, due to a combination of factors: vitamin deficiency, prevalence and toleration of flies, strong and prolonged ultraviolet radiation, dust, etc. Not surprisingly, since these etiological factors tend to come to a peak in the summer months of April-June, at this time too eye disorders reach an epidemiological maximum. The incidence of a common eye infection which villagers call ā̃kh ānā ("coming to the eye") may reach virtually universal proportions among small children in some places. Ā̃kh ānā in the hot season is often attributed to an excess of heat, although people also recognize that dust and sun glare are major contributors to many eye diseases. Trachoma, glaucoma, pterygium, and cataract are some of the serious opthalmic problems in India, and have been discussed by Cameron (1965), Mann (1966), Galindo (1969), and others.

2. Prevention, Diagnosis and Cure of Heat Injuries

The clothing, diet, and forms of behavior which afford some protection against the hot thermal environment in North India have been described in previous chapters and are essentially those which are also designed to prevent heat injuries. In addition, a few specifics against the much-feared attack of lū lagnā may be noted. These include such magico-religious devices as charms and amulets, which are widely employed by the devout, the superstitious and those--a majority of the rural lower castes--who feel themselves vulnerable to a hostile and pestilential environment over which they have little control. According to the Brahmanical tradition a charm or amulet is known as jantra (Bhoj. jantar) and it derives its efficacy from the prayers known to the Brahmans which embody and convey spiritual or supernatural force. Village women and lower-caste men, especially, seek jantars from Brahmans to protect themselves, their cattle, and above all their infants and small children, from disease and the anger of gods. The Brahman writes a certain mantra or efficacious prayer (preferably on a small piece of birch bark), folds it, and ties it with a thread. His client then may sew it into a small piece of cloth or fit it into a small copper locket or amulet of the type sold in every bazaar, to be worn usually around the neck or on the right arm. Interestingly enough, Hindu and Muslim villagers alike may also obtain charms from holy men of the Islamic faith. These charms (Bhoj. tabīj, from Urdu tavīz), like those given by Brahmans, are considered potent by reason of embodying the spiritual force of a prayer, in this case often a written passage from the Koran. Charms or amulets aimed exclusively at protection against lū lagnā--or evil spirits embodied in the lū--are uncommon; usually the lū is only one among a number of hazards against which the charm is considered effective.

Throughout North India there is an interesting association between the lū phenomena and onions (especially, raw white onions of the small variety). For one thing, onions are harvested in April, just at the beginning of the lū season. Almost everyone is aware of the time-honored custom of keeping a raw onion in the pocket, tied into a corner of the dhotī or around the waist (of a child), as a protection against lū on summer days (and against ghost-attacks at any time).

> During summer when hot dry winds (loo) blow, the use of onion protects from the evil effects of the wind, and also smelling it is similarly beneficent.
> (Hamdard 1959, p. 128)

While an increasing number of people look upon the practice as mere superstition, many others still follow it with greater or lesser faithfulness. They claim that the lū is somehow diverted from the wearer to the onion, and point out that after exposure of a person to the midday heat and wind the onion becomes yellow and shriveled. Similarly, an onion may be hung above the door of a house to divert the lū. A small onion is frequently included in the necklace of amulets worn by small children. Dr. Shaligram Shukla mentions that his family customarily keep a bunch of onions hanging at the entrance of their buffalo barn.

The common denominator of these beliefs and practices is that the smell of onions keeps away hostile supernatural beings or forces. The existence of supernatural associations with the *lū* wind is indicated by the fact that sometimes, when a person has been affected by *lū lagnā*, people will remark that "one of the troops of Bhagavati Mai has run over him" (Shukla 1970).[1]

In addition, raw onion is recommended in the hot season diet by many people and it figures in some of the treatments for heatstroke (see below). It is interesting to note that in Ayurvedic and popular dietetic theory the onion is generally called a "hot" food. However, it also has the specific quality of destroying Pitta, increasing Kapha, and stimulating the appetite, and is therefore not incompatible with the hot season. At the popular level onions are in relatively good supply in May and are so enjoyed by many people (even though Brahmans generally taboo them on religious grounds) that when one asks if they have a "hot" or a "cold" effect, some informants reply that they are "cold". One Camar in village Madhopur stressed the "delicious fragrance, flavor and color" of onions and theorized that they have a "cold" effect because it requires so much water (supplied by irrigating small plots near wells) to grow them. The *ā̃kh ānā* or "pink eye" so much encountered in eastern U. P. in the hot season (and attributed to an excess of heat) is treated by the dropping of onion juice in the ear (the left ear if the left eye is affected and the right ear if the right eye). One informant--a well-educated Muslim chemist in Delhi--described the application of raw onion juice in the ears as well as on the head and neck as both a preventive and a curative of *lū lagnā*. He said that in the hot season, when there is danger of his contracting fever and headache from the heat, his wife feels the lower part of his ear when he returns home from work. If the ear feels cool it is a sign that the sun and heat have affected him and raw onion juice is applied. Various similar therapeutic uses of raw onion juice are described by Bhandari (1951, Vol. VI, pp. 103-107), who agrees with Dr. S. Shukla (1970) that raw onion has a "cold" effect medicinally, regardless of its dietetic properties.

---

[1]The Mother Goddess of the Hindu Shaivite tradition in her terrifying aspect (called Bhagavati Mai in eastern U. P.) is feared and propitiated as the cause and at the same time the very persona of smallpox, cholera, plague, and other epidemic diseases which are most frequent in hot weather. Thus, it is especially at this time that she and her supernatural "troops" are thought to be in constant movement in paths and fields.

Throughout North India, incidentally, great care is taken to cover the ears both in extreme heat and in winter cold. This is in accord with the belief that heat or cold can readily penetrate the head through the ear passage. In the strict Muslim religious fast of Ramadan, in fact, putting medication in the ears or the nose is forbidden as being equivalent to ingesting food, due to their assumed connection with the throat passage. Of course, Hindus also feel that the head is sacred:

> The head comes in for special attention in India, where it is regarded as the part which belongs to God. Whenever a bit of cold weather came on, men wrapped their heads in woolen scarves, lengths of coarse homespun, towels or whatever came to hand. Anointing the hair and caring for the beard are other signs of this veneration. To keep the head warm and dry will avert diseases and prevent them from entering the body. (Smith 1962, p. 205)

According to Kaviratna, in India sick persons are not permitted to wash the head (Kaviratna 1890-1901, p. 178n), and there are many other taboos related to the head (Walker 1968, Vol. I, p. 432).

Most people who admit that onions are a "hot" food, when asked about the apparent contradiction of using them in the summer, offer the following kind of explanation. They say: "Iron cuts iron" (<u>lohā lohē kō kāttā hai</u>) or "Poison kills poison" (<u>jahar jahar kō mārtā hai</u>). This is a familiar Hindu idea. Thus, in connection with the notorious Tantric Shakta cults in which men and women ritually copulated without regard to caste or kin, Barton says:

> The theory which underlies these societies is that man is a creature of passion, that passion is poison, but a poison that can be cured only by poison. (Barton 1920, p. 673)

Similarly, North Indians hold that guavas should not be eaten in the winter because they are "cold". However, once one has fallen ill because of chill or the effects of cold, the consumption of guavas in quantity may then be prescribed as a curative. This is the same logic that those people who do believe that onions are "hot" apply to their dietary use in summer.

Everyone recognizes the paramount importance of adequate fluid intake in preventing lū lagnā. "One must never walk outdoors at the time of lū with the stomach empty"--this is the warning of every informant. In referring to an "empty stomach" they mean that even if a person has not eaten food, he should under no circumstances fail to drink a good portion of water or other fluid before leaving the house. Ām kā pannā, the drink made from roasted unripe mango pulp, is considered to be both a specific preventive and a curative of lū lagnā. One District Medical Officer of Health assured me that he suffers greatly from heat on summer days when he neglects to drink mango pannā before striking out into the countryside on his rounds, but never feels discomfort when he does drink it.

This is not at all the attitude which obtains with respect to salt, however. A great majority of my informants stated that salt intake should not be increased in the summer season, despite the fact that they think of salt as a "cold" food. The reason offered was usually: "Salt makes one thirsty". It is not clear what lies behind the desire to prevent undue thirst, beyond the fact that classic Ayurveda regarded any excess of salt as incompatible with the hot season. One explanation may lie in the fact that many North Indian villagers are wary about drinking water away from home, at some strange well or locality, either for reasons of caste-related pollution, or else because drinking water is often blamed for minor indispositions.

> Village folk hold that if one drinks water from some place other than his own he may develop cold and cough. (Hasan 1961, p. 58)

Dr. Shaligram Shukla cites a well-known Bhojpuri proverb: "Guru karai chāni kē; pānī[1] pīyai jāni kē", which may be loosely translated to mean: "Take a spiritual preceptor only after careful 'filtering' (searching); drink water only when you know its source". There is here a certain play on the verb chānnā ("to filter" or "to strain"), which is applied

[1]The linguist will see the symbolic importance of pānī (water) to Hindustani speakers in the fact that the word's writ is extended, in a secondary meaning, to cover "climate" in general. Thus, when Mrs. Ashby's servants were told the family was moving to Gaya in Bihar, they wailed that "Gayā kā pānī bahut kharāb hai", or "The water [climate] of Gaya is very bad" (Ashby 1937, p. 157).

to one's proper approach to finding a guru, although literally it would be applicable only to a liquid. The proverb shows the great importance which North Indians attach to their drinking water and its purity, but above all to its ritual potability, its freedom from any pollution by lower caste touch.

The best evidence from dietary studies in North India suggests that the normal year-round intake of salt, even if it is not increased in summer, is probably adequate to maintain the proper electrolyte balance during the season of intense heat, dryness and increased perspiration loss. Various studies by the Indian Council of Medical Research show an average daily intake of about 10 - 12 grams of sodium chloride for sedentary workers and 18 - 20 grams for laborers in North India. These are rather high intakes, and most Indians would be inclined to agree with Hamdard's Village Physician that

> A person can avoid sweet and sour things for weeks
> but can scarcely live for two days without salt.
> (Hamdard 1959, Vol. I, p. 182)

It is possible, moreover, that many villagers who deny using additional salt in summer may in fact do exactly that, since such hot-season preparations as ām kā pannā and sattū require the inclusion of at least some salt. In village Madhopur in eastern U. P. lower caste laborers definitely use more salt and less sugar in sattū than do the more sedentary upper castes. In fact, a nutrition expert in Patna told me that the sattū used in Bihar typically contains about four times as much salt as is used if the cereals and legumes are prepared in the normal way in the form of capātīs, boiled rice, or pulses. Most better-educated Indians with whom I spoke--excepting some Ayurvedic vaidyas--recognized the need for some increase in salt intake during the summer.

With respect to the folk medical therapy for principal heat-related disorders, villagers describe a considerable variety of treatments that may be given to a person who suffers from lū lagnā. Variation in this respect is largely a matter of family or local preference and availability. In fact, as one Camar untouchable admitted to the author, "We people will try anything that someone tells us". However, in all cases the emphasis is on cooling the patient, allaying his thirst, and massaging his limbs.

The most popular treatment is *ām kā pannā*, the drink prepared from roasted unripe mangoes. In addition to its choice as a drink, the roasted pulp is rubbed over the patient's body.[1] (Actually, the upper part of the mixture is drunk, while the dregs or thicker portion remaining at the bottom of the jar is used for massage.) Villagers say that the mango when applied to the head "pulls the heat out".

Next to mango *pannā* the most frequently mentioned treatment for *lū lagnā* is barley flour mixed into a paste with water, goat milk, raw onion juice, or some other liquid. This is applied to the body to give a cooling effect. Less commonly the patient's body (or at least the head) is cooled with water, earth, mud, ground onion, goat milk, etc. A few cases were also described in which the victim of *lū*-stroke was buried to his head in cool earth. This seems to be especially favored among the riverbank-dwelling caste of Mallahs or boatmen. More often, however, the patient is kept lying on a wet sheet on a charpoy and is fanned vigorously by someone.

Tonic and recuperative drinks given to the *lū*-stroke patient may be of many kinds besides mango *pannā*: for example, *sharbats* of wood-apple (*bēl*), of onion juice, of aniseed, of mint, etc. Other popular remedies for *lū* are drinks prepared from the dried leaves of Bengal gram or from coriander.[2] They are soaked in water, mixed with sugar, and strained. More urbanized people often use various brand-name tonics or refreshing drinks such as Amric Dhara, Roohafza, *jal jīrā*, *amaltās*, etc. The flowers of the *nīm* tree, a favorite remedy against cholera, may also be tied to the head of the victim of *lū*-stroke, and the symptom of anuria is treated by a decoction of *nīm* flowers.

---

[1]Massaging the body is a procedure of such wide application and importance in India that it deserves separate study. Babies are regularly massaged with a paste of mustard in winter, and one of barley flour with turmeric in summer. The rural barbers (Nai caste) often include a massage as part of their service to upper-caste patrons. Physical fatigue or exhaustion are normally treated by massaging, and extensive therapeutic massage is recommended in Ayurvedic texts.

[2]Opler has pointed out that coriander is the spice that is usually recommended in eastern U. P. in folk remedies for illnesses attributed to disorders of the humor Pitta (Opler 1963, p. 34).

Hamdard's _Village Physician_ fails to consider the treatment of heat injuries as such, other than prickly heat, but at least a dozen of the nearly 400 medicinal plants and substances identified in this work are described as beneficial in cases of headache, fever, and other malaise resulting from heat exposure. Among these are coriander, emblic myrobalan, henna, honey, neem, _ratanjōt_ (_Onosma echioides_), _īsaphgōl_, tamarind, vinegar, and violets. Some typical recommendations are:

> In the hot weather when one suffers from excessive thirst and prevalence of sanguine and bilious humours, 5 tolas of dried amla [_ãvalā_] are steeped in water in a new earthen jar, and the water drunk . . . (Hamdard 1959, Vol. I, pp. 200-201)
>
> . . . in the hot season a drink may be made from [honey] mixed with lime juice. Besides invigorating the body it also protects from the effect of heat. (_Ibid_., Vol. I, p. 218)
>
> . . . persons having a burning sensation during urination or passing bloody urine, or those who have a burning sensation in the hands, feet, or head due to heat or are affected with heat-stroke should be given to drink one tola of this herb [_ratanjōt_] ground along with 5 grains of pepper in water, strained and sweetened with sugar-candy to relieve these conditions. (_Ibid_., Vol. I, p. 277)
>
> In case of headache due to heat, isphagula [plantago or _īsaphgōl_] seeds are steeped in water along with green coriander leaves and applied to the forehead . . . (_Ibid_., Vol. I, p. 304)

In eastern U. P. a common treatment for headachy effects of walking in the hot sun is application of pumpkin (_kaddū_) seed oil to the head.

Villagers admit to considerable uncertainty and possible error in the diagnosis of _shītāng_, and the varied and often contradictory treatments described by informants further emphasize that this disorder has no single counterpart in Western medicine. In _shītāng_ it is felt that heat and cold in dangerous combination are the factors which are etiologically predominant. The layman's diagnosis is made by feeling the pulse and examining the tongue and eyes (which are said to be "white" if shītāng is present) The popular belief is that such a patient will recover or will die in either $2\frac{1}{2}$ hours or $2\frac{1}{2}$ days.

One of the most frequent treatments for shītāng involves massaging the body with a special kind of clay preparation. This may be the mud which forms the passageways of ants or termites found on old walls, or it may be the nests of mud-dauber wasps. In the latter case the wasps are driven out by smoke and the mud nests are ground up and rubbed on the body to absorb the perspiration and "remove the heat". Ashes from the hearth may also be used, as well as Bengal gram leaves. Another folk treatment consists of massaging with a mixture of three ingredients: ground linseed seeds, cow's milk, and bhābhī rang, a red decorative powder sold in bazaars. These various applications are also done to "remove the heat". A similar purpose is served by rubbing mustard oil with a brass vessel on the hands and feet. The oil turns black by interaction with the metal, and some of the heat effect is thus reduced.

A more dramatic therapy is sometimes used in severe cases of shītāng, when it is thought that the heart has become affected and hope for recovery is dim. This is the murgā (cock or chicken) treatment. A live rooster is cut or split in half ventrally and tied over the head of the patient. Some say this has the effect of drawing out the heat or "poison" from the patient's body, others that it is to give a hot effect on the head when it has been affected by cold. The murgā therapy may be advised by a local curer, but it is carried out by a family member. It is an extreme treatment of last resort, and is restricted to non-vegetarian families, especially those of lower or untouchable castes.[1]

---

[1] But, of course, it is precisely the class of landless agricultural laborers, the bulk of whom in North India are made up of the great Camar caste of untouchables, who are most liable to severe heat injuries. In his recently published study of caste tensions in the same village (Madhopur) which has so often been cited in these pages, the psychologist Dr. Kailash Singh has incidentally provided evidence that a very frequent--perhaps a stereotyped--complaint of the Camars is that their landlord-employers, the Thakurs, "'. . . sit in the shade and take it easy while we toil and dry up blood in the hot sun'" (K. K. Singh 1967, p. 57).

Other treatments described for shītāng are intended to warm cold hands and feet, e.g., rubbing them with lukewarm cowdung ashes. Village informants state that doctors nowadays treat shītāng by injections. This would not be surprising, since injections are so popular as a method of treatment among rural Indians, despite the unscrupulous quacks who victimize them through the hypodermic needle. Vaidyas are said to prescribe two preparations known as Chandra Bhairav and Kasturi Bhairav for shītāng.

As noted earlier, many of the summertime refreshing drinks may also have some tonic or semi-medicinal functions, especially the prevention or cure of abnormalities, real or suspected, of the male genito-urinary system resulting from the effects of "heat" in the body. The popular bēl or wood-apple, widely used as a refreshing sharbat in the hot season, and with a foremost reputation in obstinate cases of diarrhea and dysentery, is also recommended to control nocturnal emissions. The same purpose is served by a decoction of gadahapūranā, a wild grass-like plant ("hog-weed?") found in villages, whose smallish roots are ground and mixed with water to make a cooling drink.[1] Okra roots are also beaten and crushed in water, producing a sticky gum-like solution which is mixed with water and drunk in the summer by those men with "weak constitutions", urinary problems, "thin watery sperm", etc.[2] Some other "tonic" sources used in this way in eastern U. P. are: the seeds of tūtamalangā (not identified); water distilled from soaked flowers of murlī, an unidentified weed that grows in paddy fields (this is also useful for blood impurities); water mixed with the ground leaves of shīsham (Indian rosewood, Dalbergia sisu); arhaul (Bhoj.), a kind of red flower which is eaten fresh; and a sharbat prepared from baherā (the fruit of a jungle myrobalan). The seeds or fruit of makhānā (Euryale ferox) are a common medicine in the treatment of seminal gleet (Kirtikar and Basu 1918, p. 73; Bhandari 1951, Vol. VIII, p. 9).

---

[1]It is typical of the village's repertoire of "medicinal" plants that most have more than one use. Thus, a decoction of gadahapūranā is also prepared by the Mali caste (flower-gardeners, who serve as informal ritual intermediaries between villagers and the goddess of smallpox) as a prophylaxis and palliative for smallpox. And isabgōl is a mild laxative which "cleans the stomach", as well as being a cooling drink.

[2]Chopra says that "a decoction of the fresh unripe capsule [of okra] is administered in gonorrheal cystitis and urethritis and other conditions where there is difficulty in micturition" (Chopra 1933, p. 560).

For prickly heat, the principal village treatment is application of a special kind of powdered clay known as kothvār. This is derived by pulverizing the wall material of an old grain storage bin. (These bins are built from clay mixed with straw and rice husk.) The special quality of the powder derived from this source, and which villagers apply to body areas affected by prickly heat, is that it does not stick to the body. Hamdard's Village Physician also recognizes a special kind of clay (described as "Bole Armeniac" or multānī maṭṭī) as the best treatment for prickly heat. This is a yellowish-white, heavy, stratified earth, often used by women for washing hair. (It cleans the hair and leaves it soft and shining.) For prickly heat, the clay is steeped in water and applied for a few days (Hamdard 1959, Vol. I, p. 159). Other external applications for prickly heat listed in this source are:

1. Green henna leaves ground in water.
2. One tola (11.5 grams) of poppy seeds ground in goat's milk.
3. "White sandal" (Santalum album) made into a paste with water.
4. Leafshoots of neem ground in water. (Ibid., Vol. II, pp. 166-167)

E. Heat Disorders in Indian Homeopathic Medicine

It is a fact of cultural history, well known to all persons interested in Asia, that the Buddhist religious movement virtually died out in India, the country of its birth, although it spread over much of the Eastern world. Not so well known, however, is a rather similar situation in the field of medicine, involving Western countries. A German physician, Samuel Hahnemann (1755-1843), is generally regarded as the father of the homeopathic system of medicine which in the 19th century was further elaborated in the U. S. A. and Europe and once had a considerable following throughout the Western world.[1] But today homeopathy has little more than an antiquarian interest here, while in South Asia it has attained wide approval and acceptance, with no fewer than ten homeopathic medical

[1] (See Gumpert 1945). Hahnemann's principal opus was Organon der Heilkunst, translated and published in the English-speaking world as Organon of the Healing Art.

journals published in India and Pakistan (Index Medicus Homoeopathicus Cumulativus, 1961), and some 12,000 full-time and 5,000 part-time practitioners in Uttar Pradesh alone, according to a recent newspaper account (National Herald, Oct. 11, 1966).[1]

Homeopathy's popularity in early 19th century western Europe and America is not surprising in view of the state of the orthodox medical art at the time. Thus, Holmes' Principia Medicinae, a standard work in medicine 165 years ago, recommended venesection, cupping, blisters, setons and issues, clysters, emetics, purgatives, sudorifics, leeches, and scarification (Wood 1942, p. 278). As a young physician, Hahnemann rebelled at the brutality, the crudity and ineffectiveness of the medical arsenal of his time. His first formulation of the philosophy of homeopathic medicine appeared in 1796, and its first principle was that of similia similibus curantur or "like cures like", the theory that a disorder is most effectively and safely treated by a minute quantity of a drug which in a healthy person will produce the same symptoms as those seen in and subjectively felt by the sick person. His two other principles have been described as:

> 1. Vitalism: that the patient's symptoms usually represent a natural attempt to restore health and should be reinforced rather than combatted; and
>
> 2. Purposiveness: that the patient's symptoms shift meaningfully, a curative response being signaled by a symptomatic shift from more vital to less vital organs with the symptoms disappearing in the reverse order of their appearance, the newest first, the oldest last. (Stephenson 1962, p. 393)

All these are old ideas in medicine, having roots in Paracelsus, Galen, Hippocrates, and the Oriental schools.

---

[1]Since the Homeopathic Enquiry Committee estimated that there were probably close to 100,000 homeopathic practitioners in all of India in 1949, these figures do not appear to be exaggerated, even though 12,000 is approximately the number of qualified doctors of all kinds practising in U. P. It must be remembered that somewhat fewer than 10% of the practising homeopaths have completed the 5-year Degree Course in Homeopathy (or its equivalent) approved by the Government of India in 1955.

Hahnemann created a new synthesis, and added his own unique contribution in the form of the ultra-molecular dilutions. He may in fact be regarded as one of the unrecognized founders of scientific clinical pharmacology. The evolution of the homeopathic materia medica during the 1800's was the result of years of "drug proving" by Hahnemann and by others, in which hundreds of drugs and substances were said to have been tested on healthy persons as controls in varying "potencies" or degrees of dilution. However, only one medicine was ever administered at a time--this is the principle of monopharmacy which is still carefully followed in homeopathy.

In 1817 Cuvier classified zoology into four great kingdoms. About the same time Hahnemann attempted to arrange diseases in a similar fourfold classification. One of these divisions included all ailments deriving from external mechanical sources--wounds, fractures, poisons, thermic conditions, etc. The other three types of sickness were referred to by Hahnemann as "miasms", a German term which a modern English interpreter of homeopathy believes is best translated as "stigmata" or "blights"--certain characteristic conditions or effects, comparable to a virus at the cellular level. In addition,

> The same stigma may be laid upon the constitution of an individual by acquiring the disease, if the virus is not thoroughly eradicated from the system. (Roberts 1942, p. 183)

In this case the miasm tends to become almost a humoral dyscrasia.

Hahnemann gave the three "miasms" the names psora, syphilis, and sycosis. The three are not really coequal, however, for the great majority of disease conditions fall into the category of psora, which is called "the mother of diseases". Psora derives from the Hebraic tsorat ("a groove, a fault") and implies some deficiency in the system, or an inability to assimilate an essential element from food, or a lack of balance in the equilibrium of health, or some combination of these as the underlying cause of sickness. Since psora tends to be a chronic miasm it is usually first made manifest in the skin.

The two remaining stigmata of venereal type were not initially separated from each other by Hahnemann. The disease of syphilis is regarded as the manifestation par excellence of the syphilitic miasm, but this latter includes other infections as well. More important, however, is the idea that when syphilis is "suppressed" it becomes a dyscrasia, tainting the whole constitution and resulting in a pattern of "syphilitic" symptoms and characteristics that are distinctive. The third miasm, sycosis (which Hahnemann alternatively thought of as gonorrhea or "fig wart disease") also assumes its special importance through what are believed to be the organic effects of a suppressed gonorrheal infection, generally resulting in anemic, rheumatic, catarrhal and other insidious systemic conditions.

The three miasms, blights or dyscrasias have their characteristic differences: the effects of psora are functional, those of syphilis ulcerative, and those of sycosis marked by infiltration and deposits. As Roberts says,

> The very earmarks of the various stigmata show their respective characters. The psoric itches, and appears unclean, unwashed. The syphilitic ulcerates and the bony structure is changed. The sycotic infiltrates and is corroded by its discharges. (Roberts 1942, p. 218)

In other words, psora generally acts on the nervous system, producing functional disturbances which, in the homeopathic view, are mitigated by surface manifestations.[1] Thus, homeopaths oppose the treatment of the latter alone and try to go to the root cause in their therapy. Syphilis, when suppressed, attacks the larynx and throat, the eyes, the bones and periosteum, the meninges of the brain, etc. Sycosis produces such results as inflammation, abscesses and cystic degeneration, has its worst effects on the internal and sexual organs, and when suppressed characteristically leads to moral degeneracy and mental disorder.

---

[1]It appears that a hundred years ago allopathic and homeopathic medicine were not so far apart in their adherence to this idea. Witness a very interesting statement by a leading British authority on medical problems in India of the time. Speaking of prickly heat, he said: ". . . the condition relieves the system of much heat that, if undischarged in this manner, would induce mischief in the abdominal viscera predisposed to diseased action. To this extent the popular belief in the salutary influence of prickly heat is probably well founded . . ." (Fayrer 1884, p. 949).

Of course, the three "miasms" frequently act in combination. For example, tuberculosis is a psoric-syphilitic disease. In other respects too they can display variable tendencies depending upon other factors. Hence, modern homeopathy stresses its principle of "treating the person, not the disease entity", insisting that each patient manifests the condition in his own way, by his own symptoms (Shadman 1958, p. 176). Indian homeopaths whom I interviewed emphasized the long, exhaustive, detailed questioning of the patient's subjective symptoms, habits and attitudes which is considered essential to proper treatment. The questionnaire used by homeopaths is a long and interesting document indeed.

Although homeopathic medicine in the United States has left a legacy of pharmacopeia and "drug proving", it has been overrun and virtually eliminated by its failure to match the dramatic advances of modern or allopathic medicine. The humoral or constitutional approach to personality and to therapy at best meets a cold reception in modern medicine and in Western science, and that of homeopathy has certainly proved unpersuasive on theoretical grounds. At the same time, there are those ruminatively-inclined persons who detect a certain wisdom in the homeopathic philosophy that may be too often neglected today. This is the idea that a sort of re-establishment of harmony and equilibrium in psycho-somato-environmental relationships can be the most potent of therapies, and that the body's own reservoir of healing strength can respond to emotion-related factors which are often little appreciated and poorly served by a medical practice that has become increasingly impersonal, mechanized, specialized, and institutionalized. Moreover, as one chronicler of medical heterodoxies has concluded,

> On many of the issues over which they have been at odds with the allopaths, the homeopaths have been shown to be right. (Inglis 1965, p. 103)

This is particularly true of the homeopathic insistence that in illness "the toxin precedes the microbe"--that microbes are the agents of the disease rather than its cause. Thus, homeopathy has long argued that the more meaningful medical research should be in the direction of such questions as why some people are immune.

This is obviously the kind of holistic, naturalistic, and preventive medical philosophy that harmonizes well with Ayurvedic and deeply-ingrained Indian attitudes. In India many homeopathic, Unani and other medically unorthodox research workers in the area of biochemistry and nutrition hold that there is good evidence of micronutrient potency, of important effects of trace elements on the body's enzyme systems which are not yet sufficiently recognized by orthodox medicine. One informant, a biochemist expert in both modern nutrition and indigenous medicine, averred that research along these lines is more highly developed at present in the U. S. S. R. than in other Western countries.

The popularity of homeopathic medicine in India is reflected in the Homeopathic Enquiry Committee's estimate that over 3 million people in the country are being treated at any one time through this system (Report of the Homeopathic Enquiry Committee, p. 35). In fact, many Indians believe that homeopathy is of Indian origin, according to Murray (1967, p. 75). So far as official sponsorship is concerned, there is an Adviser on Homeopathy in the Central Government's Ministry of Health and Family Planning, and a comparable official in most of the state ministries of health. The India News of December 4, 1970 announces that Asia's first Homeopathic Research Institute is to be set up in Howrah in West Bengal, incorporating an existing homeopathic medical college and hospital, at a cost of Rs. 60,000,000.

The Hindu "poison kills poison" idea is strikingly reminiscent of the "law of the similimum". Even the enunciation of the name of homeopathy's founder, Hahnemann, might well ring sweet in the Hindu ear, it being a near-homonym of Hanuman, the revered monkey-god whose mythical attributes include the preparation of herbal remedies.[1] A more cogent appeal of homeopathy, however, is the extreme simplicity and cheapness of its medicine, which is in the form of very small sugar-coated pills, generally costing much less than allopathic medicines or even those Ayurvedic potions using precious substances. Homeopathy is by nature oriented toward the same unorganized, individualistic practice of medicine which is still standard in most of India.

---

[1]It is Hanuman's image that is most commonly worn around the necks of children (Elmore 1915, p. 14). And homeopathic medicine is typically regarded among the eclectic middle and upper classes in India as the pediatric therapy of choice, the one especially suitable for small children (Report of the Homeopathic Enquiry Committee, p. 36). No claim is made here that these two facts are more than coincidental, however!

Some of the exponents of homeopathy in India, like their Ayurvedic counterparts, are inclined to make extravagant claims, while belittling orthodox Western medicine:

> . . . the Allopathic system has nothing to recommend itself except its surgery, which is required only on rare occasions and which can be introduced into any other system of therapeutics. (Daftari 1949, p. 66)

Homeopaths claim that the principal merit of their system is that homeopathy, while curing the disease, does not create another. However, the merit of such logic as the following is not so impressive:

> The superiority of Homeopathy to Allopathy is also proved by the fact that several eminent Allopaths after having studied Homeopathy have been converted to it and that there is not a single instance of a Homeopath being converted to Allopathy. (Ibid., p. 104)

Most of the homeopathic doctors whom I met in North India were well aware of popular or folk beliefs and practices and take these into account in their handling of patients, even if their medical sourcebooks harken to another time and place, and consist of the old classics by Boericke, Clarke, Johnson, Kent, Lilienthal, Nash, etc.[1] These have all been reprinted in Indian editions, but very little has yet been published, or even accomplished, on the further adapting and "proving" of drugs in relation to special Indian environmental conditions, as many homeopaths in India believe should be done.[2]

With respect to the homeopathic treatment for heat injuries, a number of remedies are described as being frequently found useful in cases of "sunstroke". Shadman lists 16 such: Belladonna; Glonoine

---

[1]See list of references.

[2]However, at least one Indian medical theoretician, Benoytosh Bhattacharyya, has attempted to meld the Ayurvedic and the homeopathic ideas into a single harmonious and interrelated system. His book, The Science of Tridosha, is recommended to the reader as a remarkable example of the Hindu capacity for proliferation and synthesis of ideas.

(nitro-glycerine); Aconite; Veratrum viride (white halavorus or American hellebore); Melilotus (white clover); Amyl nitrate; Camphor; Cactus; Gelsemium (yellow jasmine); Lachesis (lance-headed viper); Stramonium (Jimson weed); Arnica (leopard's bane); Carbo vegetalis (vegetable charcoal); Natrum carbonicum (sodium carbonate); Natrum muriaticum (common salt); and Pulsatilla (pasqueflower).[1] Most of these, but especially the first four, were also described to me by North Indian homeopaths as the most useful in cases of "lū lagnā". However, these doctors repeatedly emphasized that, according to the homeopathic theoretical system, there is no specific medication for heatstroke as such. Indeed, Athalye's recent book on homeopathy in the Indian setting quite fails to mention heat injuries or the effects of heat, although it describes the appropriate homeopathic medications for malaria, cholera, dengue, etc. (Athalye 1962).

According to homeopathic belief, it is the particular individual and his symptoms which must be uniquely treated, even in the case of heat injury, which falls in Hahnemann's classification of mechanical or non-miasmic diseases.[2] As in Ayurvedic medicine, if the heat injury patient appears to have a constitutional or humoral taint or susceptibility, this must be taken into account in arriving at the appropriate therapy. This idea is well illustrated in a classic homeopathic textbook, Allen's The Therapeutics of Fevers, which contains five pages on the characteristics of the fever or heated condition per se, and some 16 pages listing the variety of concomitant symptoms, each of which calls for a distinctive treatment (e.g., coldness in the abdomen, burning in the abdomen, delirium, coma, desire for apples, desire for beer, etc.). The homeopaths admit and indeed insist that a cure is dependent upon the correct selection of that specific drug among several generally similar or comparable remedies which exactly matches the patient's subjective and objective symptoms. Not only that, but the proper dilution of the medicine must also be made, and an error in potentiation alone is sufficient to thwart a successful outcome.

---

[1]These identifications have been made in accordance with the most recent edition of The Homoeopathic Pharmacopoeia of the United States.

[2]Thermal effects similarly fall in this category in the ancient Ayurvedic classification of Caraka. Indeed, Ackerknecht has noted that "sun-stroke is one of the few diseases generally regarded as 'natural' by primitives" (Ackerknecht 1946, p. 472).

(Homeopaths stress, however--and Indian patients always say--that even at worst no harm can result from a mistaken homeopathic diagnosis and treatment, since the quantity of drug that is given is so minute.)

Shadman states:

> Belladonna absolutely covers the text-book description of sunstroke--even at its worst. (Shadman 1958, p. 432)

But in view of the variability in symptoms presented by individual heat injury cases (see Appendix B), the same statement could almost be made of at least 15 other homeopathic remedies, any of which might in a given case be the appropriate treatment rather than belladonna. In fact, Arndt thinks glonoine is the most important remedy for heat effects (Arndt 1899, p. 648). According to Nash (cited in Shadman), relief of pain upon bending the head back signifies belladonna, while increase of pain from this movement points to glonoine. Glonoine has more disturbance of the heart's action, belladonna more intense burning of the skin. Tingling sensations tend to be an earmark of aconite, although for this to be the indicated remedy there must be a particular combination of half a dozen other symptoms also. The same is true of the following also:

Amyl nitrate ("headache after heat exposure with sense of choking and oppression in the chest")

Camphor ("a feeling of coldness all over, interrupted with flashes of heat")

Cimicifuga

Ferrum phosphoricum ("dizziness and vomiting after exposure to the sun")

Gelsemium ("of great value when blinding headaches with great prostration remain as a sequel of sunstroke")

Lachesis

Opium ("cold extremities, jerking muscles, hot sweating, etc.")

Stramonium ("loquacious delirium, sensitivity to noise and contradiction")

Veratrum viride ("ringing in the ears, tongue white with red streak down the center")

Zincum phosphoricum[1] ("difficulty in concentrating one's mind and depression of spirits")
(Arndt 1899, pp. 684-5; Shadman 1958, pp. 431-5)

In India homeopaths do not approve the use of ice in treating heat injuries. However, they do usually recommend bathing the patient in water. One eminent homeopath told me of the preventive value of bathing in the evening with water which has been left exposed to the *lū* during the day in an open container and thus has become somehow charged or permeated with a quality which gives protection against the dreaded hot wind and the heat on the following day. It is possible, however, that he was describing a folk belief (in Patna, Bihar) rather than a homeopathic idea, despite the aspect of *similimum*--and of sympathetic magic--that is apparent.

---

[1]Bhattacharyya, in his ambitious Ayurvedic-homeopathic hybrid system, lists Camphor and Ferrum phosphoricum among the "Six Jewels of Homeopathy", the only six homeopathic drugs which are strong enough to affect all three Ayurvedic *dōshas* simultaneously. Most of the other drugs listed here as homeopathic remedies for "sunstroke" are classified by Bhattacharyya as "Pitta medicines" (Bhattacharyya 1951, p. 31).

LIST OF REFERENCES

Ackerknecht, Erwin. 1946. "Natural diseases and rational treatment in primitive medicine", Bulletin of the History of Medicine, Vol. 19, pp. 467-497

The All-India Ayurvedic Directory 1937 (N. S. Mooss, ed.). 1937. Kottayam: The Vaidya Sarathy

Allen, H. C. 1902. The Therapeutics of Fevers. Philadelphia: Boericke and Tafel

American Institute of Homeopathy. Committee on Pharmacopoeia. The Homoeopathic Pharmacopoeia of the United States (7th ed.). 1964. Philedelphia and Chicago

Arndt, Hugo R. 1899. A Practice of Medicine. Philadelphia: Boericke and Tafel

Ashby, Lilian Luker. 1937. My India. Boston: Little, Brown and Co.

Athalye, V. V. 1962. Fourty-four Years' Practice in Homeopathy. Poona: Anath Vidyarthi Griha Prakash

Bābur Nāma (F. G. Talbot, ed.). 1909 London: Arthur L. Humphreys

Banerji, S. C. and Siddhu, C. M. S. 1965. "Study of the factors and attitudes of medical officers working at primary health centres in Uttar Pradesh", Indian Journal of Medical Sciences, Vol. 19, pp. 789-794

Barton, George A. 1920. "Sodomy", pp. 672-674 in Encyclopaedia of Religion and Ethics (James Hastings, ed.), Vol. 11. Edinburgh: T. and T. Clark

Bhaishajyaratnavalī (of Shri Govind Das). 1951. Banaras: Caukhamba (Chowkhamba) Press (in Hindi)

Bhaṇḍārī, Shrīcandrarāj "Vishārad". 1951. Vanaushadhi-Candrōday (An Encyclopaedia of Indian Botanys and Herbs). Varanasi: Chowkhamba Sanskrit Series Office (in Hindi)

Bhattacharyya, Benoytosh. 1951. The Science of Tridosha. New York: Gotham Book Mart

Bihar. Directorate of Economics and Statistics. 1961. Annual Report on Hospitals and Dispensaries in Bihar, 1955. Patna

Blair, Chauncey J. 1961. Heat in the Rig Veda and Atharva Veda. New Haven: American Oriental Society

Boericke, William. 1961. Pocket Manual of Homeopathic Materia Medica. Calcutta: Roy Publishing House

Brown, Hilton. 1948. The Sahibs. London: William Hodge and Co.

Bulsara, Jal F. 1970. Patterns of Social Life in Metropolitan Areas. Bombay: Research Programmes Committee of the Planning Commission, Government of India

Burridge, William. 1944. Climate and Labour. Allahabad: Kitabistan

Cameron, Malcolm E. 1965. Pterygium throughout the World. Springfield, Illinois: Charles C. Thomas

The Charaka Samhita. 1949. Jamnagar: Shree Gulabkunverba Ayurvedic Society (6 vols.)

Carstairs, Robert. 1895. Human Nature in Rural India. Edinburgh and London: William Blackwood and Sons

Chandrasekhar, S. 1952. "India's population problem", pp. 24-45 in Foods and Population and Development of Food Industries in India. Mysore: Central Food Technological Research Institute

Chatterjee, Tarun. 1967. "Acupuncture", The Modern Review, Vol. 121, pp. 215-220

Chopra, R. N. 1933. Indigenous Drugs of India. Calcutta: The Art Press

Cikitsā-Sāhitya (Medical Catalogue No. 43). 1966. Varanasi: Chowkhamba Press (in Hindi)

Clarke, John H. 1898. The Prescriber: a Dictionary of the New Therapeutics. Philadelphia: Boericke and Tafel

_____. 1901. A Dictionary of Domestic Medicine. Philadelphia: Boericke and Tafel

Croizier, Ralph C. 1970. "Medicine, modernization, and cultural crisis in China and India", Comparative Studies of Society and History, Vol. 12, pp. 275-291

Daftari, Kesho Laxman. 1949. Bodily Reactions and Examination of Systems of Therapeutics. Bombay: Hind Kitabs

Danon, A., Weller, C. P., and Sulman, F. G. 1969. "Effect of dry hot desert winds on man", pp. 71-72 in Biometeorology, Vol. 4, Part II (S. W. Tromp and W. H. Weihe, eds.). Amsterdam: Swets and Zeitlinger N. V.

Dastur, J. F. 195-. Medicinal Plants of India and Pakistan. Bombay: D. B. Taraporevala Sons and Co.

Dewar, Douglas. 1922. Bygone Days in India. London: John Lane

Dhillon, H. S. 1966. Personal communication

Dutt, Udoy Chand. 1877. The Materia Medica of the Hindus. Calcutta: Thacker and Spink

Fayrer, Sir Joseph. 1882. On the Climate and Fevers of India. London: J. and A. Churchill

_____. 1884. "Health in India", pp. 913-958 in The Book of Health (Malcolm Morris, ed.). London: Cassell and Co.

Fonaroff, L. Schuyler and Fonaroff, Arlene. 1966. "The cultural environment of medical geography in rural Hindu India", Pacific Viewpoint, Vol. 7, pp. 67-84

Fox, Richard G. 1969. From Zamindar to Ballot Box. Ithaca. Cornell University Press

Galindo, I. G. 1969. "Solar radiation intensity and atmospheric dust content as biometeorological parameters of pterygium", pp. 72-73 in Biometeorology, Vol. 4, Part II (S. W. Tromp and W. H. Weihe, eds.). Amsterdam: Swets and Zeitlinger N. V.

Gangulee, N. 1939. Health and Nutrition in India. London: Faber and Faber

Gordon, Charles A. 1857. "Observations on the statistics of diseases of the brain and nervous system, as they affect soldiers, officers, women, and children in India", The Medical Times and Gazette, Vol. n.s. 15, pp. 416-417

Gumpert, Martin. 1945. Hahnemann: the Adventurous Career of a Medical Rebel. New York: L. B. Fischer

Hahnemann, Samuel. 1819. Organon der Heilkunst. Dresden: In der Arnoldischen Buchhandlung

_____. 1833. Organon of the Healing Art. Dublin: W. F. Wakeman

Hamdard (Waqf) Laboratories. 1959. Village Physician. Delhi (2 vols.)

Hasan, Kwaja Arif. 1961. Social and Cultural Factors Affecting Health in a Rural Community. Ph. D. Dissertation, Lucknow University

Hobbs, Lisa. 1967. India, India. New York: McGraw-Hill Book Co.

Hopcraft, Arthur. 1968. Born to Hunger. Boston: Houghton Mifflin

Huschke, Ralph E. 1959. Glossary of Meteorology. Boston: American Meteorological Society

India. 1961. Census of India, 1961

India. Ministry of Health. 1948. Report of the Committee on Indigenous Systems of Medicine. Delhi (2 vols.)

_____. 1949. Report of the Homeopathic Enquiry Committee. Delhi

_____. 1951+ Health Statistics of India. Delhi (annual)

_____. 1963a. Report of the Shuddha Ayurvedic Education Committee. Delhi

_____. 1963b. Summary Proceedings of the Special Meeting of the Central Council of Health, held in New Delhi 9-10 April 1963. Delhi

India News (Embassy of India, Washington, D. C.)

Indian Institute of Public Opinion. 1967. Monthly Public Opinion Surveys, No. 147 (December 1967), pp. 12-15

The Indian Nation (Patna)

Inglis, Brian. 1965. The Case for Unorthodox Medicine. New York: G. P. Putnam's Sons

Jayaswal, Hari Prasad. 1948. A Geographical Study of the Chunar Tahsil, District Mirzapur (U. P.). M. A. Thesis, Department of Geography, Banaras Hindu University

Johnson, Isaac D. 1889. Johnson's Therapeutic Key. Philadelphia: F. E. Boericke (16th ed.)

Kaikini, V. M. 1965. "Romance of ancient Hindu medicine", Indian Journal of Medical Science, Vol. 19, pp. 631-641

Kaviratna, Avinash Chandra (ed.). 1890-1901. The Charaka Samhita. Calcutta: the editor

Kent, James T. 1932. Lectures on Homeopathic Materia Medica. Philadelphia: Boericke and Tafel (4th ed.)

Kincaid, Dennis. 1938. British Social Life in India, 1608-1937. London: G. Routledge and Sons

King, E. Augusta (Mrs. Robert Moss King). The Diary of a Civilian's Wife in India, 1877-1882. London: R. Bentley and Son

Kirtikar, K. R. and Basu, B. D. 1918. Indian Medicinal Plants. Bahadurganj: Suhindra Nath Basu

Kuvalayananda, Swami and Vinekar, S. L. 1968. "Concept of disease in yoga", Indian and Foreign Review, Febr. 15, 1968, pp. 17-18

The Leader (Allahabad)

Leslie, C. M. 1963. "The rhetoric of the Ayurvedic revival in modern India", Man, Vol. 63, pp. 72-73

_____. 1967. "Professional and popular health cultures in South Asia: needed research in medical sociology and anthropology", pp. 27-42 in Understanding Science and Technology in India and Pakistan (Ward Morehouse, ed.) Occasional Publication No. 8, Foreign Area Materials Center, University of the State of New York

_____. 1968. "The professionalization of Ayurvedic and Unani medicine", Transactions of the New York Academy of Sciences, Series II, Vol. 30, pp. 559-572

_____. 1969. "Modern India's ancient medicine", Trans-action, June 1969, pp. 46-55

Levick, James J. 1859. "Remarks on sunstroke", American Journal of Medical Sciences, Vol. 37, pp. 40-55

Lewis, Oscar. 1958. Village Life in Northern India. Urbana: University of Illinois Press

Lilienthal, Samuel. 1925. Homeopathic Therapeutics. Calcutta: Sett Dey and Co.

Lind, James. 1788. An Essay on Diseases Incidental to Europeans in Hot Climates. London: J. Murray (4th ed.)

Mann, Ida. 1966. Culture, Race, Climate and Eye Disease. Springfield, Illinois: Charles C. Thomas

Mann, R. S. 1966-67. "Concepts of diseases and change in a Delhi village", Indian Journal of Social Work, Vol. 27, pp. 353-360

Marriott, McKim. 1955. "Western medicine in a village of northern India", pp. 239-268 in Health, Culture and Community (Benjamin D. Paul, ed.). New York: Russell Sage Foundation

Marshall, John. 1668-1672 [ed. 1927]. John Marshall in India. Notes and Observations in Bengal [ed. Shafaat Ahmad Khan]. London: Oxford University Press

Megaw, Sir John. 1939. "Medicine and public health", pp. 181-215 in Social Service in India (Sir Edward Blunt, ed.). London: HMSO

Murray, David Stark. 1967. India--Which Century? London: Victor Gollancz

Murty, G. S. 1961. "Small pox", pp. 53-61 in Report on the State of Health of Uttar Pradesh. Lucknow

Nadkarni, K. N. 1954. Indian Materia Medica. Bombay: Popular Book Depot (2 vols.)

Napier, L. Everard. 1943. The Principles and Practice of Tropical Medicine. Calcutta: Thacker, Spink and Co.

Nash, Eugene B. 1913. Leaders in Homeopathic Therapeutics. Philadelphia: Boericke and Tafel

National Council of Applied Economic Research. 1965. Techno-Economic Survey of Uttar Pradesh. New Delhi: NCAER

The National Herald (Lucknow)

O'Meara, Eugene John. 1935. I'd Live It Again. London: Jonathan Cape

Overseas Hindustan Times

Pathyāpathya Nirūpan. 1961. Prayāg: Jagannāth Prasād Shukla Vaidya (in Hindi)

Planalp, Jack M. 1956. Religious Life and Values in a North Indian Village. Ph. D. Dissertation, Cornell University (University Microfilms No. 56-979)

Pradīp (Patna) (in Hindi)

Prasad, B. G. 1961. "Cholera", pp. 6[illegible]-72 in Report on the State of Health of Uttar Pradesh. Lucknow

Prasad, Narvedeshwar. 1968. "Solar altitude and planning of urban architecture in the Ganga valley, India", p. 351 in 21st International Geographical Congress. Abstracts of Papers (Sivaprasad Das Gupta and Teresa Romanowska-Lakshmanan, eds.). New Delhi

Roberts, Herbert A. 1942. The Principles and Art of Cure by Homeopathy. London: Homoeopathic Publishing Co.

Sen, Kaviraj Gananath (Gaṇānatha Sena). 1916. Hindu Medicine. Madras

Shadman, Alonzo J. 1958. Who is Your Doctor and Why? Boston: House of Edinboro

Shastri, J. K. n.d. (1943?) Presidential Address, 31st All India Ayurvedic Congress, Lahore 1942. Gondal

Shepherd, H. M. D. 1945. "Effects of heat in Iraq", Journal of the Royal Army Medical Corps, Vol. 84, pp. 1-8

Shukla, Shaligram. 1970. Personal communication

Singh, Kailash K. 1967. Patterns of Caste Tension. Bombay: Asia Publishing House

Singh, Khushwant and Joshi, Arun. 1968. Shri Ram: a Biography. New York: Asia Publishing House

Sinha, K. L. 1952. "Strong winds at Allahabad and their forewarnings", Indian Journal of Meteorology and Geophysics, Vol. 3, pp. 101-114

Smith, Bradford. 1962. Portrait of India. Philadelphia: J. B. Lippincott Co.

Spear, T. G. P. 1932. The Nabobs. London: Oxford University Press

Spencer, J. E. and Thomas, W. L. 1948. "The hill stations and summer resorts of the Orient", The Geographical Review, Vol. 38, pp. 637-651

The Statesman Weekly

Stephenson, James. 1962. "Homeopathic principles", pp. 392-399 in Theories and Philosophies of Medicine. Delhi: Institute of History of Medicine and Medical Research

The Sushruta Samhita (Kaviraj Kunja Lal Bhishagratna, ed.). 1970. Calcutta: the editor

Swastha Hind. 1970. (July 14, 1970)

Taylor, Carl. 1968. "The health sciences and Indian village culture", pp. 153-161 in Science and the Human Condition in India and Pakistan (Ward Morehouse, ed.). New York: The Rockefeller University Press

Trumbull, Robert. 1957. As I See India. London: Cassell and Co.

Walker, George Benjamin. 1968. The Hindu World. London: George Allen and Unwin (2 vols.)

Willcox, W. H. 1920. "The nature, prevention and treatment of heat hyperpyrexia", British Medical Journal, n.s. Vol. 1, pp. 392-399

Wise, Thomas A. 1845. Commentary on the Hindu System of Medicine. Calcutta: Thacker and Co.

Wood, James C. 1942. An Old Doctor of the New School. Caldwell, Idaho: The Caxton Printers

VI

EPIDEMIOLOGY OF HEAT INJURIES

A. General Considerations

No full historical and epidemiological study of heat disorders, and of their classification and treatment in the various medical systems and diverse cultures of the world, has yet been made. What is perhaps the earliest mention of fatal heatstroke occurs in the Bible (Judith VIII, v. 2-3; Kings IV, v. 18-20), while the most dramatic historical occurrence of heat fatalities is believed to have been that in China on July 14 - 25, 1743, when about 11,000 people perished in Peking due to a heat wave (Levick 1859, p. 41). Napoleon's forces suffered hundreds of casualties when struck by a heat wave after crossing into Russia in 1812. Other heat waves up to the present time have numbered victims at least in the hundreds if not in the thousands in several parts of the world, both in the tropics and (as in Russia in 1812) up to at least the 55th parallel.

Everyone who has looked at the broad problem of the world history and epidemiology of heat injuries has been dismayed by the difficulty in obtaining reliable and comparable data, both as to the incidence and as to the definition of syndromes. In the U. S. A. perhaps the most thorough epidemiological investigations are those of Shattuck and Hilferty, carried out nearly 40 years ago. They used official death registrations as sources, but for the most part they combined those heat fatalities where the effect of heat was regarded as primary and those where it was considered to be a secondary, although a significant contributing factor. The mean annual incidence between 1900 and 1928 in the U. S. A. was 1.9 per 100,000. But great variation was found from year to year, the highest incidence being 12.8 per 100,000 in 1901 and the lowest 0.3 per 100,000 in 1920. Hardly any American state is entirely exempt from heatstroke, but at the present time, interestingly enough, the areas of greatest hazard appear to be New York City and the Upper Plains states. Mills and Ogle's epidemiological map for the period 1924-1928 shows Iowa and Nebraska with the highest "excessive heat death rate", adjusted for age, but such Eastern Seaboard states as Maryland and Pennsylvania were also relatively high (Mills and Ogle

Preceding page blank

1933, pp. 690-692).[1] Some conclusions emerging from the Shattuck and Hilferty studies which may have relevance for an interpretation of heat injury epidemiology in North India are:

1. High environmental temperature per se is the single most important factor in the epidemiology of heat deaths.
2. But high environmental temperatures produce a large number of deaths only when they occur for three or four consecutive days.
3. A higher relative humidity tends to increase the number of deaths and a higher wind velocity tends to reduce them.[2]
4. Heat death rates are generally correlated with the size of the city, and urban death rates are markedly higher than rural.
5. A slight downward trend in heat death rates occurred from 1900 to 1928.
6. Death rates are relatively high during the first year of life, very low thereafter up to age 20, rise gradually to age 70, and rise sharply after age 70.
7. Death rates for males are three times as high as for females in the 20-70 age range, but are about the same in the under-20 and over-70 age groups.
8. Hyperpyrexia is far more common than heat exhaustion between ages 20 and 60, but heat exhaustion predominates after 60 years of age.
9. Heat effects are a primary cause of about 62.5% of registered heat deaths, and in 37.5% of such deaths they are secondary or important contributing causes. (This statement refers to Massachusetts.)

---

[1]Specific heat waves and their resultant morbidity and mortality in the U. S. A. have been studied epidemiologically by Phillips (1897), Browne (1935), Schuman, Anderson and Oliver (1964), Bridger and Helfand (1968), and others.

[2]Note that the authors here are generalizing about Massachusetts, where dry bulb temperatures seldom exceed body temperature. In air temperatures above 103^{o} F. higher wind velocity will generally increase, not reduce, heat stress (Ambler 1966, p. 280).

10. Fatigue, ill health in general, weakness of the heart muscle, hard physical exertion, taking of alcoholic beverages, unsuitable clothing, and overcrowding--all these increase the liability of heat effects.[1]

There is good evidence that heat fatalities are as much determined by relative as by absolute heat stress. Thus, the 13-day Massachusetts heat wave of July 1911 included only four days of dry bulb temperature over 100° F., with a maximum of 104° F. At the same time there was an average daily minimum temperature during these 13 days of 75° F., and an average relative humidity of slightly under 60%. For almost a billion tropical residents of this globe these are near-normal hot-season conditions which would be likely to cause few heat deaths. But the less acclimatized natives of Massachusetts sustained some 950 heat deaths in July 1911, of which 594 were due to primary heat effects.[2]

Mills and Ogle investigated the question of climatic bases for susceptibility to heat injuries, and ventured the hypothesis that

> People living in the cooler and more changeable climates possess a more active metabolism to meet the environmental demands, and find themselves less able to curb their heat production sufficiently to withstand periods of excessive heat. (Mills and Ogle 1933, p. 695)

The authors cite experimental evidence that rabbits exposed to a wide diurnal variation in temperature are more susceptible to excessive heat than rabbits not so exposed, and believe that human epidemiological figures from the southwestern U. S. A. corroborate this. Shattuck and Hilferty's more thorough investigations give only partial support to this claim, for they indicate relatively lower rural death rates from

---

[1] These conclusions are summarized, but are not quoted verbatim, from Shattuck and Hilferty.

[2] If these July figures constituted the year's total, the 1911 Massachusetts heat death rate was 0.28 per 1000 population. The annual rate was probably a little higher, assuming some additional heat deaths in the other summer months in that year.

heat injuries in the western as well as in the southeastern states, and relatively higher rates in the north-central and northeastern states (Shattuck and Hilferty 1932, p. 321).

While the regional and environmental patterns of heat-caused morbidity and mortality in a whole civilian population are not necessarily comparable to those of fatal heatstroke in a young and active military population, Schickele's excellent study of the latter has produced interesting findings. Her investigation of the circumstances surrounding 157 U. S. Army heatstroke fatalities during World War II showed a clear inverse correlation between state of acclimatization and vulnerability to heatstroke death. In addition, Schickele mapped the United States into three roughly equal-area zones based on "heat acceptance of the atmosphere for the warmest month", a heat-stress figure derived from temperature, humidity and wind. The heat death rate among soldiers originating in the coolest zone (New England, the Pacific Northwest, higher elevations of the Rocky Mountains, and the northern tier of the country) was over twice as high--4.5 per million draft-age population, compared to 1.9 per million draft-age population--as was the death rate among those soldiers who came from the warmest zone (the Southeast, Texas, and most of the Southwest) (Schickele 1947, p. 251).

Although American standards of medical diagnosis and reporting are relatively high--certainly in comparison with a country such as India--Ferguson and O'Brien point out that heat disorders are still frequently overlooked or misdiagnosed, and that official records therefore understate their incidence (Ferguson and O'Brien 1966). Epidemiological researchers studying the 1939 and 1955 heat waves in California found that, while the daily mortality rate for persons over 80 years old doubled when the temperature reached 104° F., and tripled when it reached 107.5° F., very few of the deaths were attributed on death certificates to heat itself (Goldsmith <u>et al</u>., p. 74). However, the highest proportionate increase by cause was for deaths attributed to cerebrovascular accidents and heart disease.

The contrary view is stated by Manson-Bahr, who believes that a large proportion of cases reported as heat hyperpyrexia in tropical countries are really other diseases, notably cerebro-spinal fever, apoplexy, tuberculosis, meningitis, alcoholism or cerebral malaria (Manson-Bahr 1965, p. 342). Actually,

> . . . heat stroke in middle and old age is frequently associated with degenerative cardiovascular disease, particularly arteriosclerosis, hypertension, and myocardial ischaemia . . . (WHO Chronicle 1964, p. 291)

The "reported cause of death" may therefore have dubious validity, and since medical and vital statistics in India are so much less complete and reliable than in the U. S. A. or Europe it is hardly surprising that even the meager epidemiological data that are available must be cautiously interpreted.

B. Military Epidemiology

Heat disorders have historically been of greater concern to military medicine than to general medicine. This may be because the exigencies of combat and even the conditions of training for it frequently impose a degree of physical strain in combination with environmental heat that in peacetime can be largely avoided. At any rate, army commanders recognize the vital need to understand how much heat stress is tolerable if troops are to operate with efficiency. Not only are heat effects relatively more critical in the military than in the general population, but also their statistics are more accurate and complete. This is due both to the highly structured and administratively efficient nature of military organization and to the fact that the age level of soldiers is one which eliminates much of the difficulty in distinguishing acute heat effects from the cardiovascular and other disorders that complicate differential diagnosis in the more elderly. Nevertheless, Surgeon-Commander Ellis believes that even in the armed forces

> Official records do not indicate the true incidence of heat illnesses for incapacitation is often a transient affair in healthy adult men. (Ellis 1955, p. 324)

The disabling effects of heat were early recognized as a hazard to the European soldier in North India. During the "Sepoy Mutiny" of 1857, enormous heat casualties were sustained by the British army as a result of marching and fighting during the hot season. While official medical data are not available to the author, numerous observers on the scene have left graphic written records. In many cases the severe heat losses were unnecessary, caused by injudicious orders and inappropriate clothing. In Up Among the Pandies, Majendie describes the havoc wrought in his unit when, at 2 p.m., orders to march were given instead of the customary rest in tents.[1] In the 117° F. temperature several fatal cases of heatstroke occurred while striking tents, even before the troops had fallen in. On the march

> . . . the searching rays of the sun beat through helmet, cap, and turban, and struck down by dozens the healthiest and strongest among us. (Majendie 1859, p. 281)

His description of the clinical course of individual cases is also of interest:

> With some, the attack was only temporary; in a few hours, or days, or weeks, they recovered; others lingered perhaps till evening, or the next morning, and then sank into their last long sleep; but many fell, almost as if they had been shot, and in 5 or 3 minutes were no more. (Ibid., p. 281)

It may be surmised that maximum temperatures during the months of May and June of 1857, when British soldiers and civilians were under siege in Delhi, Lucknow, Kanpur and many other places in North India, as usual ranged well over 100° F. However, there were specific local conditions, such as in the British entrenchment outside Delhi, where soldiers were exposed to additional radiated heat from the rose-pink quartz walls, and where total heat stress must have reached an almost

---

[1]However, one wonders just how beneficial the "rest" in tents could be, considering the fact that in World War I in Mesopotamia, when dry bulb shade temperatures reached 120° F., "Tents afforded poor protection, and in the double fly E. P. tents the temperature would often reach 135° or 140°. During the hot days it was necessary to wear in them a head protection--for example, a topee." (Willcox 1920, p. 394)

intolerable level.[1] Referring to June 14, 1857 in Kanpur, a recent chronicler says:

> On this day the thermometer would touch 138 degrees; even in other years, granted the gift of shade, such heat had driven men to lock themselves in darkened rooms and blow out their brains. On this day five, perhaps six, people within the British entrenchment would die of sunstroke. A band of steel seemed to encase their temples followed by a great drowsiness; they sank vomiting to their knees, faces blackening as they died. (Collier 1964, pp. 120-121)

In a single action described by Majendie, lasting two hours from 4 p.m. until 6 p.m., the English combat losses were 2 or 3 killed and perhaps 6 wounded. But heatstroke claimed 160 casualties and 50 deaths.

> Dozens of strong men lay speechless and insensible, gasping and jerking with a convulsive, tetanic action. Bhisties [water-bearers] stood over them saturating their heads with cold water. (Majendie 1859, p. 281)

While British army losses due to heat casualties in 1857 were very heavy, the chronicles of the period provide us no information on their occurrence among the various groups of sepoys, irregulars and guerrillas who opposed them. One might assume such losses on the Indian side to be lower, for their access to rest, shade and water was better.[2] But as the rebellion was gradually brought under control, it appears that

---

[1]Lord Roberts describes "sunstroke" deaths in the Delhi action occurring on June 23 and on July 3, 1857 (Roberts 1901, pp. 95, 101).

[2]Traditionally, in both ancient and medieval India, armies avoided combat in extreme heat (Sinha 1965, p. 147), and during conflicts in the early days of the British East India Company also native armies generally broke off contact at midday and resumed the battle at a later hour (Barber 1965, p. 185). However, sufficient military professionalism was evident among the sepoy rebels on a number of instances for them to launch attacks during the midday heat, when the British defenders were most vulnerable.

British army commanders took steps to spare their own men as much as possible from the torrid climate, for Gordon reports that in 1858

> The extreme heat of the weather then was dangerous to European troops, and it was desired to spare them as much as possible. Native troops were therefore to be pushed forward, with the Europeans held in reserve. (Gordon 1906, p. 34)

Official British army heat morbidity records for "European" and "Native" troops are available at least from 1910 (Shattuck and Hilferty 1936). They show a striking difference between the two ethnic groups, the heat morbidity rate for British soldiers in India averaging 4.6 per 1000 annually for the years 1910-1931, while the rate for "Native" soldiers averaged 0.42 per 1000. For the British soldiers the lowest annual rate during this 21-year period was 0.7 per 1000 in 1913 and the highest rate was 19.0 per 1000 in 1921. For "Native" soldiers the lowest year was 0.09 per 1000 in 1913 and the highest was 2.24 per 1000 in 1918. Most of the difference between the two military groups, incidentally, was due to heat exhaustion (a 50: 1 ratio between British and Indian troops). For heatstroke, the relative incidence was not very different as between British and Indian personnel (Raina 1961, p. 527).

It is probable that the large year-to-year fluctuations in heat morbidity shown in these British Army medical records are more or less correlated with the year-to-year fluctuations of temperature averages (or, even more, of heat wave occurrence), although even a rough comparison of the British and "Native" figures indicates that the relationship is imperfect and other factors are involved. One factor that has long been known to exert an overriding effect on the tropical heat morbidity rates is the state of acclimatization of the population at risk. In years when large numbers of unseasoned British recruits were sent to India the rate rose markedly.

Naturally, the military incidence of heat cases has always been greater in war years than in peacetime in India. In 1942 nearly 2000 men (of whom 75% were British, and 25% Indian) were admitted to army hospitals in India suffering from effects of heat. Heatstroke accounted for less than 300 of these admissions, but was blamed for 98 of the 136 deaths which resulted. While we do not know the total military population at risk, it is clear that the morbidity rate indicated by these statistics is only a fraction of that which occurred during the same year in Iraq and Iran: 88.7 per 1000 among British troops and 32 per 1000 among Indians (Raina 1961, p. 522). Incidentally, while this approximately 3: 1 heat morbidity ratio obtained between British and Indian forces in Iraq and Iran, a 6: 1 heat mortality ratio was reported. But any statistical comparisons between British and Indian soldiers are suspect, since we do not know if similar standards or definitions of illness requiring medical treatment obtained. Overall hospitalization rates for "Native" troops were always much lower than those for British troops in India.

Most authorities state that the majority of military cases of heat injury in India occurred in the Panjab and the North-West Frontier provinces and during the week or two prior to the onset of the southwest monsoon (late June) and in the breaks during the monsoon (July-August) (Ibid., p. 522; Simmons 1944, Vol. I, p. 129). A military surgeon as long ago as 1857 said much the same thing:

> Indian medical officers are . . . aware of the fact, that the disease termed apoplexy, coup de soleil, or insolation, is not so much to be dreaded during the intensity of the dry heat, when the hot winds prevail in greatest force, as in those calm, sultry days, when the sun is obscured either by a film of clouds or by the impalpable dust at that season diffused through the atmosphere. (Gordon 1857, p. 417)

Napier mentions that half the annual total of heat hyperpyrexia cases in India in the British army occurred in the month of June, according to official medical records (Napier 1943, p. 35). Military personnel and training have been disproportionately concentrated in northwestern India, accounting for some discrepancy between military and civilian heat injury epidemiology. The data presented in the next section, derived from the contemporary North Indian civilian population, tend to confirm the salience of the immediate pre-monsoon period in heat-stroke danger. However, they do not show that the monsoon breaks, despite the extreme discomfort which they invoke, are statistically very productive of serious heat injuries.

Unlike in Iraq, where during both World Wars charts were kept at Basra in attempts to relate daily heatstroke incidence to dry bulb temperature, wet bulb temperature, relative humidity, night-time minimum temperature, etc., the critical environmental factors in the etiology of heat injuries among military personnel in India have not been much studied, or at least are not well reported in the literature. An interest in the maximum terrestrial altitude for the occurrence of "sunstroke" in India led one observer to a search of the records, with results indicating that 1500 ft. is its limit (Marsh 1930, p. 277).

Anecdotally, an experienced medical officer once noted the high heat mortality among British sergeant-majors in Lucknow, which he attributed to over-consumption of beer (Sir Thomas Carey, remarks in Marsh 1930, p. 278).[1] Sir Thomas claimed that in the Lucknow cases the heatstroke collapse and death frequently occurred during the night, whereas in Mesopotamia heatstroke during the night was rare, the nights being relatively cool. Mrs. King's reference fifty years earlier to 17 heat deaths in a newly-arrived British regiment at Lucknow seems to substantiate this, as she says explicitly:

> It is not the sun that kills them--merely the heat of the air. (King 1884, p. 260).

But Willcox, from his experience in the same area, has suggested that there is a cumulative effect of heat stress and a time lag in its production of actual collapse:

> . . . a man might be exposed to heat for one or more days and then develop an attack of heat hyperpyrexia in the night or early morning after the atmospheric temperature had fallen considerably. (Willcox 1920, p. 393)

[1]There is good comparative evidence connecting alcoholic consumption with heatstroke vulnerability. Thus, of the total of 841 cases described as "sunstroke" and analyzed by Phillips during the August 1896 heat wave in the central and eastern parts of the U. S. A., 20% had consumed no alcohol, while 30% had used it "to excess", and 50% "moderately". But among the 140 fatalities, the comparable percentages were 10%, 60% and 30%, respectively (Phillips 1897, p. 229). Similarly, there were 158 cases and 70 deaths attributed to heatstroke seen in Cook County Hospital in Chicago in July 1916. Laborers constituted about 65% of the victims and it was judged, based on interviews with these patients, that about 92% had drunk beer or other liquors in the preceding 24 hours, in quantities ranging from several glasses to a gallon (Gauss and Meyer 1917, p. 558).

Incidentally, in speaking of cool nights in "Mesopotamia", Carey was surely not thinking of the Persian Gulf area, for

> A chart kept at Basra in 1943 had shown a general correlation between the high temperatures at night generally prevailing during these spells and the actual occurrence of individual cases. (Raina 1961, p. 531)

Hearne's carefully plotted charts maintained at Basra in the summer of 1917 showed such an insignificant relationship between daily heatstroke incidence and any meteorological conditions that he did not even publish them. He could note only a slight overall correlation of heatstroke with the wet bulb temperature (Hearne 1932, p. 321). (The summer of 1917 at Basra saw a heat wave in which there were 18 consecutive days of plus-119^{o} F. temperature and heatstroke occurrences on 62 out of 66 days, with 44 cases on the peak day.)

Among those who have studied the nature and epidemiology of heat injuries in Iraq, Ladell and his colleagues directed attention to individual differences in salt requirements and to the importance of cumulative effects or build-up of heat stress and susceptibility over a period of time (Ladell <u>et al</u>. 1944). Morton also found that the greatest incidence of casualties occurred on the third or fourth day of a heat wave, even though conditions on the fourth day might be no worse than on the first (Morton 1944). Taylor was the first of many observers to recognize that in the Persian Gulf region wind speed and direction play an enormous role in heat stress and in heatstroke epidemiology (Taylor 1919). Taylor also noted that the heatstroke rate among British and Indian troops in Iraq in 1917 was much greater in the presence of intercurrent sandfly fever and malaria. Napier saw this latter relationship as an important factor in the differential British and Indian heatstroke incidence in India also:

> . . . heat trauma is seldom uncomplicated and is usually induced by some febrile infection, such as sandfly fever, to which the Indian soldier is more likely to be immune. (Napier 1943, p. 18)

The Indian Army today is somewhat more representative of the entire population than it was under British sovereignty, when the "martial races" were disproportionately represented. Indian Defence Forces scientists are presently studying differences between recruits from different regions and habitats of India in their reaction to extreme environmental factors of heat, cold, and altitude, and their findings should appear in the future.[1] Based on some combination of prejudice and first-hand experience, British military commanders formerly held definite opinions on the subject of the climatic adaptability of the various Indian Army units:

> The monsoon is so harmful to north Indians that for the Burma campaign the British sent troops from the Madras Army, and not from the Bengal Army, which was recruited from the Punjab and U. P. (Chaudhuri 1965, p. 139)

And in the Younghusband Tibetan campaign, at 15,000 ft. a detail of Madras Sappers and Miners were found to be particularly vulnerable to the cold and soon had to be sent back to warmer zones (Fleming 1961, p. 128).

No published information is available to the author regarding recent heatstroke incidence in the Indian Defence Forces. In fact, the only information at all that I have on the epidemiology of military heat injuries in India is an oral statement, made by an Indian Army Medical Corps Colonel well acquainted with the official statistics, that about 200 cases of heatstroke were reported throughout the Indian Army in 1964. I do not know the number of fatalities, but another high-ranking Army medical officer candidly admitted to me that, because the Indian Surgeon-General requires such lengthy and detailed explanations ("about 50 forms have to be filled out") from the responsible unit commanders and medical officers whenever a heatstroke fatality occurs, there is a tendency to "cover up" or disguise the few heatstroke deaths that do occur in the course of training.

---

[1]This work falls under the aegis of the Defence Institute of Physiology and Allied Sciences (Surgeon-Commander M. S. Malhotra, Director), who kindly allowed me to tour their laboratories in Madras and in Jodhpur in October 1966. The main laboratories have now been relocated in New Delhi.

C. Recent Epidemiology of Heat Injuries in Uttar Pradesh

One must burrow more prodigiously into the dusty archives of history than I have been able to do in order to make more than an educated guess as to the toll of deaths wrought over the centuries by heat waves in North India. The next section of this chapter gives a partial record of one such, in 1966 in the state of Bihar. Its casualties were probably much increased by concurrent drought and near-famine. In the more distant past this association must have been even more lethal, for Miss Ashmore described a scene of 135 years ago near Kanpur, of multitudes of villagers walking under a burning sun in May to escape famine, and leaving uncounted numbers of dead and dying along the roadside--whether from starvation or from heat collapse, it is impossible to say (Ashmore 1841, p. 244). As these words are being written, in late May of 1970, newspapers carry articles describing a prolonged heat wave in North India, with up to 120° F. temperatures, that has already produced numerous fatalities.[1]

So far as recent published official records and data are concerned, virtually nothing can be said about the epidemiology of heat injuries in the general population of North India.[2] Up to the present time these disorders have not constituted one of the "notifiable" categories of morbidity or mortality. Indeed, even the longer report used in hospitals and dispensaries for the medical officer-in-charge to record his diagnosis does not contain, among its 150 or so columns, any place for heat exhaustion or heatstroke. Such cases are among those which

---

[1] The Statesman Weekly of May 23, 1970 reported over 100 deaths in Bihar, plus a "sizeable number that go unrecognized", and over 200 deaths in Maharashtra. Time (June 15, 1970, p. 26) gave the total figure of heat wave deaths for all of India as 800, in round numbers.

[2] The only such published report that has come to my attention is that of Pai (1965), in which the annual rate of "accidental" deaths officially attributed to excessive heat in the city of Bombay during the 20-year period 1942-1961 was calculated at 0.6 per million population (compare with Table 6). Bombay is, of course, a coastal city whose sultry climate (101° F. is the highest temperature on record) produces monotonous, prolonged heat stress, but not the extremely high temperatures found on the North Indian plains.

should be included in a residual "Other" category and briefly identified. However, my own examinations of the official records on file indicated that doctors usually do not describe a sickness or death recorded in the "Other" column.

Nor do the health statistics tabulated and published by the State governments include "hyperpyrexia", "heat exhaustion", "heatstroke", or even "heat wave", as causes or descriptors of morbidities and mortalities. Perhaps partly for this reason members of the Indian Parliament in New Delhi have at least twice--in 1962 and again in 1966--felt it necessary during the hot season to direct parliamentary questions to the Central Minister of Health asking for information on the number of cases of "lū lagnā" or heatstroke and the measures being taken to ameliorate them. In order to prepare a response the Health Ministry, through its Central Bureau of Health Intelligence, on both occasions queried the various State health ministries, who in turn circularized their district medical officers and hospital superintendents for the information.

In Uttar Pradesh there are presently 54 districts, each with two responsible medical officers. One of these, the Civil Surgeon, has authority over the district civil hospital and the allopathic dispensaries, now known as "Primary Health Units" or "Primary Health Centers", in his district. The other official, the District Medical Officer of Health (hereafter referred to as DMOH), has responsibility for preventive medicine, vital statistics, and also the Ayurvedic dispensaries in his district.[1] In addition to these two officials, the Superintendents of some seven or eight large city and medical college-affiliated hospitals in U. P. report independently to the Director-General of Medical and Health Services of the state (hereafter referred to as D-GMHS).

---

[1]There were (as of 1964) 15 government homeopathic dispensaries in U. P. also, but I am not certain as to their administrative control. Nor do I know the total number of Ayurvedic dispensaries. At any rate, both Ayurvedic and homeopathic dispensaries were ignored in the heatstroke surveys made by the government in 1962 and 1966.

It can be seen that "official" health tabulations in U. P. and other Indian states do not include outpatients of private physicians nor those individuals who are treated in a variety of other institutions ranging from a few small but highly-regarded medical missionary hospitals down to private clinics and treatment centers maintained by doctors of allopathic, Ayurvedic, Unani, homeopathic, naturopathic and other persuasions. Although 89.9% of doctors in Uttar Pradesh holding a degree in modern medicine are practising in the "public sector" (i.e., as government employees), it should be noted that most of them are allowed to carry on a private practice as well.

Recognizing that official morbidity statistics in India are incomplete since, except in respect to "notifiable" diseases, they include only cases presented to a government dispensary or a major hospital, there is still the question of the reliability of the officially reported figures themselves. The threat of severe epidemic diseases in North India is so immense that government health officials have taken heroic steps to try to obtain complete and accurate figures on the occurrence of the "notifiable" diseases--smallpox, cholera, plague, malaria, filariasis, tuberculosis, etc. By and large these statistics are fairly reliable. In the case of essentially minor and chronic disorders, however, the official statistics are so inadequate and even capricious as to constitute a standing joke among knowledgeable Indian epidemiologists. For example, the 1957 Annual Report on Hospitals and Dispensaries in Uttar Pradesh showed the occurrence of 4694 cases of yellow fever and nearly 100,000 cases of undulant fever. The latter figure is preposterous, while yellow fever is well known to be completely absent in India thanks to strict health and customs controls (Davis 1951, p. 42; Murty 1963).

Although the D-CMHS of Uttar Pradesh dutifully circularized all responsible medical officials to obtain first-hand statistics on the incidence of heat injuries in 1962 and 1966 and conscientiously totaled up the reports received, every important Central and State health official to whom I talked warned against accepting the figures at face value. Some went so far as to brand them entirely worthless. In the first place, almost all mild cases and a large proportion of serious or even fatal cases of heat exhaustion and heatstroke are not brought to a government dispensary or hospital, and are thus unreported. Secondly, the shortage of government doctors is so great and their workload so heavy that they naturally accord low priority to the time-consuming tabulation of records and the answering of circularized inquiries such as this. In fact, the Civil Surgeon enjoys a sinecure in his post to such a degree, and is an official of such independence and authority in his District, that he can ignore with impunity most routine requests and directives from a higher level.

Given the difficulties of reliable diagnosis and reporting of heat injuries in North India it might be expected that mortality rather than morbidity figures would be a more useful indicator of epidemiological factors. However, many of the same problems beset this approach. The quality of vital statistics reporting is evidenced by the fact that during the 1951-61 period only 38.4% of the estimated births and 37% of the estimated deaths in U. P. were registered (Census of India 1961. Vol. XV. Uttar Pradesh. Part 1-B, p. 41). Indeed, this represents not an improvement but a decline in registration compared with previous decades going back to 1891.[1] Autopsies are seldom performed and in virtually all of U. P. except the urban areas the cause of death is certified not by a medical official but by a layman, the elected headman (and formerly by the even less well-educated village watchman).

Having become aware of the deficiencies in official reports, I sought to obtain somewhat more accurate epidemiological data by contacting personally a number of Civil Surgeons and DMOH's and also by sending out to all 108 of them in January 1964 a relatively brief and simple questionnaire--sanctioned in advance by the D-GMHS--aiming at determining estimates of actual rather than "official" incidence of heat injuries. Considering the circumstances, the receipt of responses to this questionnaire covering 32 of the total 108 officials is surprisingly good, although in many cases the information provided is fragmentary or superficial, probably reflecting the official's simply having turned the matter over to one of his clerks.

At any rate, some of the resulting data are useful for comparing with the official figures gathered by the D-GMHS of Uttar Pradesh in 1962 in response to Parliamentary Question No. 7529, asked by Dr. L. S. Singhvi in the Lok Sabha on June 12, 1962 and in 1966 in answer to Parliamentary Question No. 2482, asked by Shri P. C. Borooah on May 31,

[1]The Registration of Births and Deaths Act, 1969, which came into force on 1 April 1970, for the first time now makes the registration of births and deaths compulsory, with effective penal sanctions (Chandra Sekhar 1970, p. 271).

1966. According to these two official surveys, the following numbers of "lū"--apparently interpreted to mean essentially "heatstroke"--cases were treated in hospitals and dispensaries in U. P. for the years 1957-1966:[1]

Year	Cases	Deaths
1957	418	36
1958	565	72
1959	565	61
1960	1255	204
1961	593	58
1962 (to June 30)	574	79
1963	377	38
1964	407	57
1965	521	86
1966 (incomplete)	537	71

One year--1960--stands out in this period for its abnormally high incidence of heatstroke cases and deaths, while the fewest number of cases occurred in 1963. Climatic factors are of course largely responsible for year-to-year fluctuations in overall heatstroke incidence. During the month of May in 1963, for example, only two plus-110° F. days occurred in Allahabad, compared to an average of about 10 such days according to the climatological record, and the highest temperature recorded during the month was 112° F., compared to a normal monthly maximum of 115° F. (Northern India Patrika, June 1, 1966, p. 3). In 1960 a prolonged heat wave occurred throughout U. P. from June 2 to June 16, which is reflected in the official statistics of heatstroke casualties. During this time maximum temperatures were over 110° F.

[1] I obtained these data in October 1963 and again in October 1966 from the Medical Health Section of the D-GMHS of Uttar Pradesh. The 1966 totals are incomplete since at the time of my visit the Superintendent of one hospital and some three or four (out of 108) of the Civil Surgeons and DMOH's had not yet submitted their reports, requested three months previously.

almost every day and reached a peak of 118° F. at several stations. In 1966 again all-time record high temperatures occurred in much of eastern U. P. on June 9, following a month of above-average temperatures. Despite the heavy death toll, unprecedented in recent years, that occurred in the neighboring state of Bihar, however, the heat fatality total in U. P. for 1966 was normal.

With respect to the total figures reported here (an annual average during the 10-year period of 581 cases of heatstroke treated in hospitals and dispensaries, and 76 deaths), the district medical officers whom I polled were uniformly skeptical. Estimates as to the actual or true incidence ranged from twice to 1000 times that officially reported, the mean being about 10 times. One Civil Surgeon, whose district (Hamirpur) reported an average of 9 "lū" cases per year in the 1962-66 period, estimated that actually anywhere between 100 and 500 cases had occurred. Most of these cases of course were either home-treated or were taken to a private practitioner--perhaps a doctor with some amount of medical training, or perhaps a local quack, "faith-healer" or village herbalist. The Hamirpur Civil Surgeon noted that mild heat exhaustion in these conditions is often diagnosed as diarrhea, gastro-enteritis or cholera, while mild cases of heatstroke are generally attributed to one or another of a variety of fevers.

In October 1966 Dr. T. Bhadury, chief epidemiologist in the D-GMHS, gave me an off-the-cuff estimate of 4 or 5 per 1000 annual incidence of total (including "mild") heat injury cases in U. P. Although this does not appear to be a high rate compared to those previously reported in various military populations, it would project to an astounding 300,000 or 400,000 annual cases in U. P., a figure vastly greater than those forwarded in answer to the Parliamentary Questions. Even if 90% of these are mild cases, the remainder would be over 50 times the total officially reported.

Perhaps the only organization in North India approximating the military forces in size and medical efficiency is the Northern Railway, many of whose 46,000 employees are required to work strenuously in conditions of extreme heat. Northern Railway medical services cover not only employees, however, but also their dependents, an estimated total of some 230,000 persons. In 1966 a total of 180 heatstroke and 1427 "heat exhaustion" cases were recorded by Northern Railway medical officers, a rate of 7 per 1000 based upon the total population covered by medical services. In actual fact, almost all these cases occurred among the employees proper, making the annual rate closer to 30 or 35 per 1000. However, the Northern Railway Chief Medical Officer, Dr. D. R. Bhasin, admitted that the category "heat exhaustion" is so liberally interpreted, especially for the drivers, firemen and gang-men who are most severely heat-stressed, that the figures probably include a large proportion of simple "heat fatigue" or even malingering. (Dr. Bhasin noted that some workers claim they can artificially develop a fever by placing an onion in the armpit.) The most surprising feature of the 1966 Northern Railway medical records, however, is the complete absence of fatalities resulting from heatstroke. Unless such fatalities have been disguised in order to avoid annoying, time-consuming inquiries and investigations, the absence of any deaths in this heat-vulnerable occupation during a year which witnessed new record maximum temperatures is really incredible and can only be attributed to a high level of preventive medicine and prompt medical attention.

The heatstroke records collected by the D-GMHS of U. P. provide only a limited breakdown by month for three of the ten years. They exclude the months of August and September, apparently on the assumption that few cases are seen during these months. The number of cases and deaths for April through June 1962 and the number of deaths for April through July 1964 and 1965 are available. Despite the paucity of data, the figures for the three years agree rather closely in showing that approximately 4% of cases and deaths occurred in April, 30% in May, 64% in June and 2% in July (n = 652).

The Northern Railway records differ somewhat from this pattern, however.[1] Combining the figures for heatstroke and "heat exhaustion", they show 6% of total cases in 1966 occurring in April, 37% in May, 47% in June, 9% in July and 1% in August (n = 1607). If heatstroke alone is used, only 12% were recorded in May, with 83% in June, nil in July and 5% in August (n = 180). Percentages derived from a single

[1] Geographically, the Northern Railway covers most of the states of Panjab, Hariyana, and Rajasthan, in addition to Uttar Pradesh.

year, or even from three or four years, should be accepted only tentatively, of course, but those represented here tend to support Raina's observation that the most critical time for heat injuries in the central area of the North Indian plains occurs during the two or three weeks preceding the monsoon, i.e. June 1 - 20 for most of Uttar Pradesh.

My questionnaire to Civil Surgeons and DMOH's asked for an estimate of the "worst month for heatstroke, for heat exhaustion, and for prickly heat". Out of 39 individuals who responded,[1] June was designated the worst month for heatstroke by all except seven, who chose May. Opinion was more sharply divided among respondents as to the peak month for heat exhaustion, possibly reflecting subjective differences in the definition of this rather inclusive term. Of 38 respondents, one described April as the worst month for heat exhaustion, 3 named May, 14 June, 13 July, 5 August and 2 September. This may be compared with Gupta's statement relating to the Panjab, an area adjacent to U. P. to the northwest:

> With the onset of Monsoons in mid July the incidence of heatstroke stops abruptly but cases begin to occur with certain other unpleasant heat effects e.g. prickly heat, heat exhaustion. (Gupta 1963, p. 117)

There is some evidence that in normal persons the bodily stocks of sodium chloride decline over the course of the hot season, presumably making the population relatively more vulnerable to salt-deficiency heat exhaustion in August and September than in May and June (Marsh 1933, p. 259).

Only 16 doctors responded to my question about prickly heat, of whom 2 named June, 6 July, 6 August and 2 September. Epidemiologically, prickly heat is very common, although it is impossible to estimate the percentage of people affected by it. In the Calcutta area, with a more

---

[1] Individual respondents exceed the number of district medical officials represented because in two cases the Civil Surgeon included separate responses from several of his subordinate medical officers in sub-district dispensaries.

prolonged hot humid regime than that of U. P. and Bihar, Jelliffe claims to have found prickly heat in 97% of the babies (average age: two years), all poorer-class <u>bastī</u>-dwellers, examined by him in May 1955 (Jelliffe 1958, p. 72). This bears out Tromp's succinct conclusion that

> . . . residents within the tropics over many years seem to be prone to the condition . . . (Tromp 1963, p. 412)

We should expect to find differences between the easternmost and the westernmost districts of U. P. in regard to the time of peak occurrence of heat injuries. This is because the average date of maximum temperature precedes the east-west movement of the monsoon and hence occurs earlier in northeastern than in northwestern India. Thus, the highest average temperature of the year occurs on April 23 in Calcutta (88°24' E. long.), on the Bay of Bengal, on May 10 in Patna, Bihar (85°10' E. long.), on May 15 in Allahabad (81°44' E. long.), on May 18 in Agra (78°01' E. long.) and on May 23 in New Delhi (77°12' E. long.) (India. Meteorological Department. <u>Five Day Normals</u>, 1965). However, these are dry bulb temperatures, accompanied in all cases by the year's lowest humidity readings, and there is evidence that if full and cumulative thermal environmental stress values were available for North India, combining temperature, vapor pressure, radiation, and wind,[1] the average date of maximum heat stress would be found to occur about 3 weeks later than the time of maximum dry bulb temperature, corresponding closely to the actual monthly heat injury totals given above.

No geographical pattern with respect to time of peak incidence of heat injuries emerges from my questionnaire. That is, responses from Civil Surgeons and DMOH's from easternmost districts and from westernmost districts of U. P. appear to show no significant differences with respect to monthly incidence. The same conclusion emerges from an

---

[1]Since Indian official meteorological readings of humidity, wind and "cloudiness" are taken only twice daily at most stations, at 0800 (recently changed to 0830) and at 1700 (recently changed to 1730), Indian Standard Time, hourly and cumulative heat stress can only be approximated from the available meteorological data.

analysis of the officially reported heatstroke case and mortality figures collected by the D-GMHS. Of course, the east-west breadth of Uttar Pradesh is only about 500 miles and the difference in time of onset of the monsoon between the two extreme borders of the state is only about 10 days (Das 1968, p. 12). The fragmentary monthly districtwise data that is available indicates relatively fewer cases of heat injury in April in eastern U. P. than in western U. P., however, and relatively more cases in July and August in eastern U. P. than in western U. P., which is exactly the opposite of the situation suggested by Raina with regard to military heat casualty epidemiology.

District-by-district totals of the officially-reported heatstroke cases and deaths for the years 1962-1966 are shown in the following table, and the annual rates of heatstroke incidence in the districts of U. P. as derived from this table are depicted in the accompanying map (see Table 6 and Figure 7). The map appears at first glance to indicate an epidemiological pattern of maximum heatstroke incidence along the southern and southwestern tier of districts, with the lowest incidence somewhat vaguely centered in the northwestern part of the state.

This map may be compared with one (Figure 8) which roughly indicates the normal annual maximum temperature experienced in U. P. The correspondence between reported heatstroke incidence during 1962-1966 and the isothermic patterns based on a long period of climatological record (60 years for most stations) appears to be fairly close.[1]

There is, however, another relationship which needs to be considered, that between the urban environment and heatstroke incidence (Figure 9).

---

[1]It may be worth noting that the three districts (Jalaun, Hamirpur and Banda) at the heart of U. P.'s hottest region are the very ones looked upon by government servants as the "Siberia" of the State, where ". . . local administrators may find themselves transferred if they are unduly recalcitrant" (Brass 1965, p. 219).

Table 6. Five-year (1962-1966) Reported Heatstroke Occurrence in Uttar Pradesh, Excluding Hill Districts

District	Population (1961)	Cases	Deaths	Incidence (reported cases per 1,000,000 population)
Agra	1,862,142	212	63	22.77
Aligarh	1,765,275	60	2	6.80
Allahabad	2,438,376	457	43	37.48
Azamgarh	2,408,052	60	0	4.98
Barraich	1,499,929	34	1	4.53
Ballia	1,335,863	3	1	.45
Banda	953,731	90	2	18.87
Bara Banki	1,414,547	5	0	.71
Bareilly	1,478,490	2	0	.27
Basti	2,627,061	NA	NA	NA
Bijnor	1,190,987	NA	NA	NA
Budaun	1,411,657	0	0	0
Bulandshahr	1,737,397	1	1	.12
Deoria	2,375,075	7	1	.59
Etah	1,299,674	0	0	0
Etawah	1,182,202	20	2	3.38
Faizabad	1,633,359	7	1	.86
Farrukhabad	1,295,071	29	7	4.48
Fatehpur	1,072,940	7	4	1.30
Ghazipur	1,321,578	32	1	4.84
Gonda	2,073,237	36	3	3.47
Gorakhpur	2,565,182	3	3	.23
Hamirpur	794,449	46	4	11.58
Hardoi	1,573,171	4	0	.51
Jalaun	663,168	34	2	10.25
Jaunpur	1,727,264	24	8	2.78
Jhansi	1,087,479	129	10	23.72
Kanpur	2,381,353	238	63	19.99
Kheri	1,258,433	10	2	1.59
Lucknow	1,338,882	75	31	11.20
Mainpuri	1,180,894	0	0	0
Mathura	1,071,279	23	3	4.29
Meerut	2,712,960	2	1	.15
Mirzapur	1,249,653	7	0	1.12
Moradabad	1,973,530	37	4	3.75
Muzaffarnagar	1,444,921	3	0	.42
Pilibhit	616,225	0	0	0
Pratapgarh	1,252,196	40	2	6.39
Rae Bareli	1,314,949	NA	NA	NA
Rampur	701,537	NA	NA	NA
Saharanpur	1,615,478	4	0	.50
Shahjahanpur	1,130,256	35	1	6.19
Sitapur	1,608,057	0	0	0
Sultanpur	1,412,984	11	4	1.56
Unnao	1,226,923	387	18	63.08
Varanasi	2,362,179	206	41	17.44

Source: Unpublished records of the Directorate-General of Medical and Health Services of Uttar Pradesh

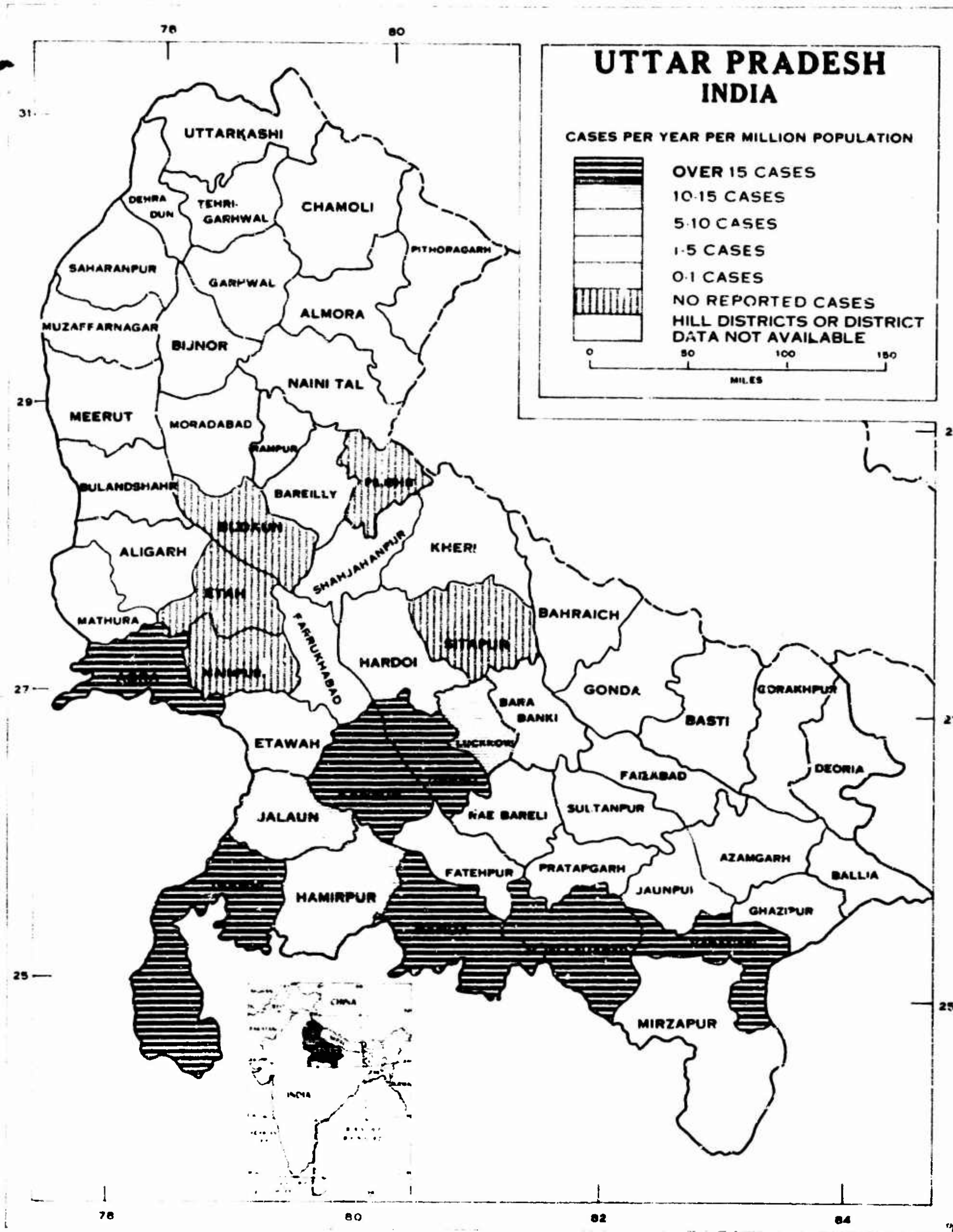

Figure 1. The Incidence of Officially Reported Heatstroke Cases in Uttar Pradesh, 1962-1966

Preceding page blank

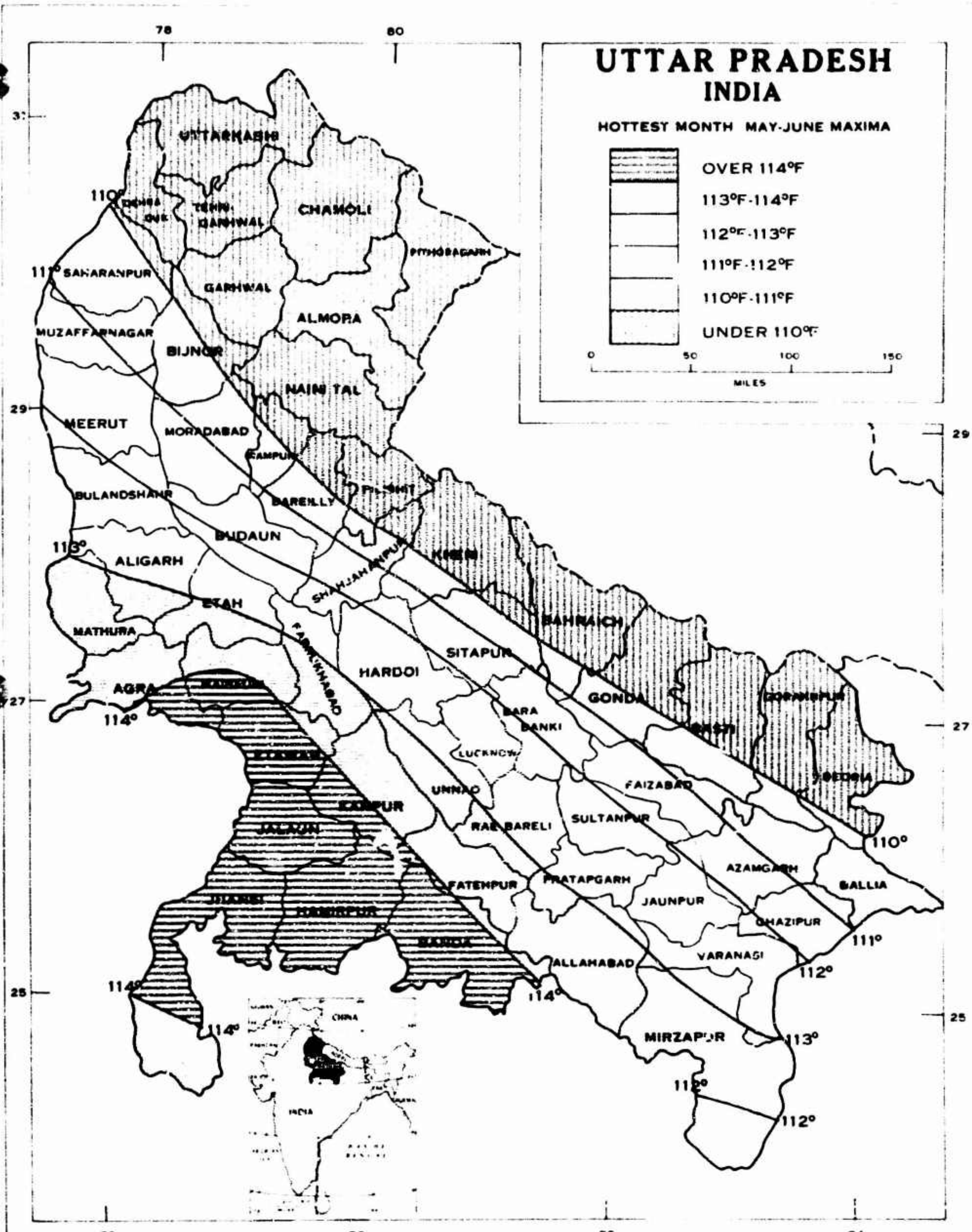

Figure 8. Mean Monthly Maximum Temperature **Preceding page blank**

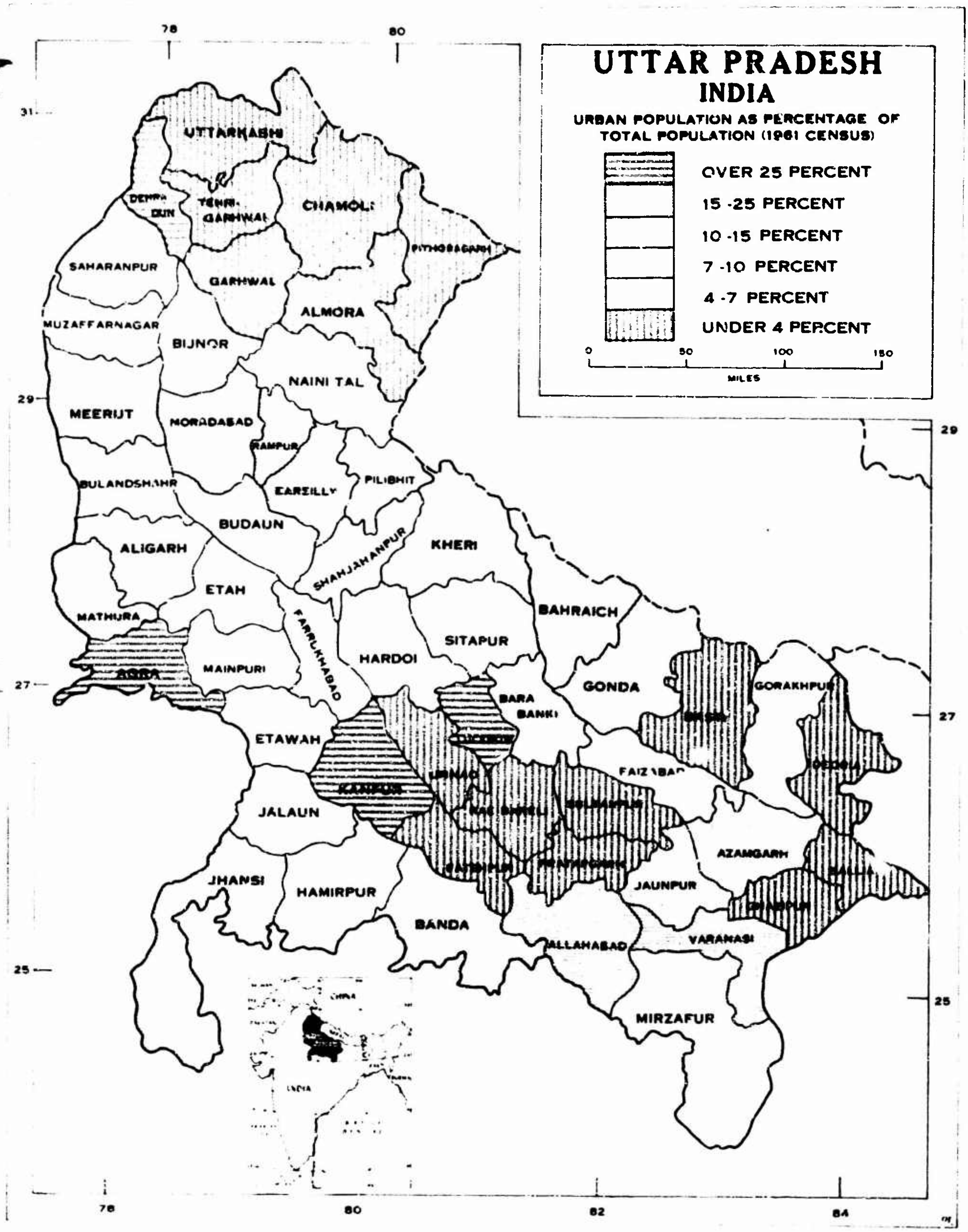

Figure 9. Urbanization Rate

Preceding page blank

This map portrays urbanization rate or percentage of urban population in the various districts of U. P., based upon the 1961 census.[1] It is probably no coincidence that the five U. P. cities with populations over 400,000 (Kanpur: 971,000; Lucknow: 656,000; Agra: 509,000; Varanasi: 490,000; and Allahabad: 431,000) are located among the ten districts with the highest per capita incidence of reported heatstroke. The heatstroke mortality statistics for 1962-1966 show the relationship even more strikingly. Sixty-three deaths were reported in both Agra and Kanpur districts, 43 in Allahabad district, 41 in Varanasi district and 31 in Lucknow district. No other district totaled more than 18.

The relationship of urbanization to heatstroke incidence in U. P. is more complex than that of temperature. There is a question as to what extent it involves differential access to medical facilities, as well as completeness of the reporting procedure, and to what extent it may reflect an actually greater vulnerability to heatstroke of the urban than of the rural population, either by reason of differences in the characteristics of the two populations or by reason of more heat-stressful conditions in cities as compared with villages.

My inquiries circulated to Civil Surgeons and DMOH's were inconclusive. Thus, 27 of these responded to the question: "Is the per capita rate of heatstroke, heat exhaustion and prickly heat in your district relatively greater in the city or in the countryside?" Of these, 13 claimed heatstroke is relatively more frequent in cities, 12 that it is more prevalent in villages, and 2 that it occurs in both areas equally. In the case of heat exhaustion these responses were 15 urban, 10 rural and 2 equal. Prickly heat was checked by only 8 respondents, of whom 6 found it more common in cities and 2 in villages.

Little of value can be added by an examination of these medical officers' justifications for their choices, or by their answers to a request to name the special groups most vulnerable to heat disorders,

---

[1]By census definition the urban population is that living in cities over 100,000 population or in towns over 5000 population with a density of more than 1000 per square mile and with 75% of the adult males in non-agricultural occupations. Decennially many villages are raised to the status of towns and some towns are downgraded to villages according to this definition.

for about 70% simply answered: "the poor and the malnourished". Those who believed the heatstroke rate to be higher in villages than in the city of course designated farmers and field laborers as the principal victims while those of the opposite opinion mentioned factory and manual laborers, cycle rickshaw drivers, cart drivers, etc. About 25% of the medical officials singled out small children and elderly people as especially vulnerable to heat disorders. However, a large minority (about 30% of respondents) claimed that middle and upper class individuals constitute a group more liable to heatstroke and heat exhaustion than the poor and laboring categories of the population. They noted that many cases of heat injury occur among persons accustomed to sedentary activity and cooled rooms when they unwisely or accidentally expose themselves to physical exertion in the high midday temperatures. These doctors apparently agreed with Wyndham, who has recently expressed concern at the over-dependence on air-conditioning in Australia, believing that it may result in the conditioning of a person to an artificial indoor climate, with a lower set-point of comfort:

> . . . every time the "artificially conditioned" person goes out from the air-conditioned space into the tropical climate he or she would then experience the air conditions outdoors as much too hot. By contrast the person who has remained "naturally adjusted" to the tropical climate would experience the same air condition as comfortable or, at the most as merely warm . . . . A continual reminder throughout the summer months every time one goes out of doors that the tropical climate is much too hot might very well have the reverse effect on the individual's morale to that anticipated by the advocates of air conditioning of all working and living spaces. (Wyndham 1962, p. 540)

The answers to my questionnaire were of course quite subjective, even if hopefully based on authoritative experience, and are unsupported by any statistical evidence. Systematic climatic studies in North India comparing urban and rural environments are scarce, although official stations in cities do give slightly higher readings on average than do those at the aerodromes adjacent to those cities. In the case of New Delhi, temperatures may vary as much as 6 F.° on any given day among any three sub-stations (Lodi Road, Palam Airport and Safdarjang Airport) which lie within only five miles of each other, the differences being due to "wind current, fog in winter and dry sunny day in summer" (Agarwala 1960, p. 278). Studies in other parts of the world have indicated significant mesoclimatic variations in temperatures, which typically decrease in outward radius from an urban center, e.g. up to 11.6 F.° difference in July in Karlsruhe, Germany between the center and the outskirts of the city,[1] and 16.2 F.° in the case of London (Chandler 1967, p. 590). In general,

> . . . the maximum difference between city and countryside appears to be about 10 to 15 degrees Fahrenheit, regardless of the size of the city. (Lowry 1967, p. 22)

The disparity between the "heat island" of a central city and the surrounding countryside is greatest at night, or when comparisons are made between daily minimum temperatures; in the daytime, or when daily maximum temperatures are compared, the difference is considerably less.

Observers in India have long been aware of the existence of local topographic factors which exert a pronounced effect on temperatures: the presence of a large body of water or of forest growth or of extensive rock outcroppings. Of relevance is the case of Banda, which has the highest daily maximum as well as average daily temperatures of all the official meteorological stations in U. P.

> The hot season is distinguished by two peculiarities, rareness of duststorms and purity and transparency of the atmosphere when in other parts of India the sky has a hazy appearance from the quantities of dust in the air. This peculiarity is perhaps in a measure due to the exhalation of moisture from the fissures of the black soil, but it is certainly largely a consequence of the fact that mar and kābar[2] give off

---

[1]Cited by Geiger (1965, p. 493). The reader is referred to Geiger's monumental work for a perspective of microclimatology.

[2]These are, respectively, "a rich dark colored friable soil, with a high proportion of organic matter and exceptional capacity to retain moisture" and "a stiff tenacious soil, with a large percentage of clay" (District Gazetteers of the United Provinces of Agra and Oudh. Vol. XVI. Banda. 1909, p. 7)

> very little dust. To this purity of the atmosphere may perhaps be ascribed the often fatal effects of the sun, deaths being frequent from exposure at midday. The large number of rocks and rocky hills absorb the heat during the day and give it off during the night . . . (District Gazetteers of the United Provinces of Agra and Oudh. Vol. XVI. Banda. 1909, p. 36)

In Varanasi I often passed along a road which parallels the Ganges River on the western edge of the city. At one point this road crosses the Assi River which, although it provided half the city's present name, is now reduced to the size of a small creek which in places a man can almost step across. Due to some peculiar effect of local topography (possibly an updraught from the Ganges along the bed of the stream), the passerby is instantly aware just as he passes over the watercourse of a pronounced drop of several degrees in the sentient temperature. This is just the type of local biogeographical variation to which Hodder has referred in Malaya:

> Innumerable observations of a subjective nature could be advanced to indicate that small differences in siting and aspect produce appreciable differences in body temperature and comfort. (Hodder 1955, p. 19)

An eminent Indian meteorologist mentioned to me that he has often encountered a folk belief in pockets of hot air, containing much higher temperatures than the surrounding norm (Bose 1966).

Parenthetically, few of us are aware of the truly enormous variations in temperatures which quite typically occur microclimatically, that is, over small periods of time and over small distances.

> For example, studies with very small temperature-sensing elements have shown temperature fluctuations at a point near the ground of 10° C. [18° F.] within a second or two, and similar measurements made at six-second intervals for a half-hour period showed a 13° C. [23.4° F.] variation. . . . At Yuma, Ariz., located in the desert of thesouth-western United

> States, a 40^0 F. difference has been observed between the temperature of the ground surface and the air at 5 ft. in early afternoon. (Henschel and McPhilimy 1963, p. 336)

Equally dramatic evidence emerges from a study made in the Neotoma Valley of Ohio, where the range in annual maximum temperature among 109 micro-stations (including "frost pockets", cliff tops, crevices, slopes, etc.) all located within a radius of 0.6 km. was 37.8 F.^{0} (from 75.2^0 F. to 113^0 F.), occurring on dates ranging from April 19 to October 3 (Wolfe, Wareham and Scofield 1949, p. 141). This is to be compared with the readings from the 88 official meteorological stations located <u>throughout</u> <u>the</u> <u>state</u> of Ohio. The range in yearly maximum temperature among the 88 stations was only 10.8 F.^{0} (from 91.4^0 F. to 102.2^0 F.), and all the maximum readings occurred within a three-day period in July. Finally, Cook has described how large numbers of heat casualties at a military training center were completely eliminated when the infiltration course was operated in the early morning rather than in the afternoon. Ground temperatures were discovered to be up to 20 F.^{0} higher than those only 5 ft. above the ground! (Cook 1955, p. 321).

North Indian cities, despite the widespread use of electric fans, the assured water supply and the far greater accessibility of medical treatment, probably do suffer a higher per capita rate of heat disorders than do the rural villages. This is a plausible assumption in view of the concentration of industries and high-stress occupations in cities, as well as the heat-retaining and heat-radiating qualities of pavements and buildings in cities, and their wind-blanketing effects. However, the fact is not necessarily proved by my data. The correlation which has been indicated between "urbanization" and heatstroke rate may well be a spurious one, reflecting two conditions. One of these is the well-known difference in completeness and accuracy of medical reporting and vital statistics between city and countryside in India. The other is the fact that patients who come to a city hospital from homes in neighboring rural districts are included in the reports of the district of hospitalization.

Granted an across-the-board underreporting factor of perhaps 5 or 10 times in the case of heat fatalities, of perhaps 20 times in the case of moderately severe heat morbidities, and of as much as 100 times in the case of mild heat disorders, there are still a number of district reports in Table 6 which are not credible. The disproportionately high heatstroke rate for Unnao District is puzzling, for this district has a low urbanization rate and there is nothing special to be noted about its climatological regime (District Gazetteers of the United Provinces of Agra and Oudh. Vol. XXXVIII. Unao. 1903). However, the high rate of heatstroke has been reported consistently (including an additional year, 1961, in which there were 59 cases), both to the D-GMHS of Uttar Pradesh and in response to my own questionnaire. Of course, the district lies directly between the two major metropolises of Lucknow and Kanpur, separated by only 50 miles, which no doubt results in an unusually heavy concentration of market gardeners, milk-sellers and other provisioners, of cartmen, rickshaw-wallahs and other transport workers, and all the other commuting traffic which is exceptionally exposed to heat and solar radiation. It would be expected, however, that many heat casualties in this situation would be "lost" to the Unnao records and fall into those reported from Kanpur and Lucknow hospitals. Regrettably, I was unable to visit Unnao personally to investigate this problem.

In the opposite case, the 1962-1966 "nil" reports submitted to the D-GMHS from Budaun, Etah, Mainpuri, Pilibhit and Sitapur Districts are suspect, and those from Meerut, Bulandshahar, Bareilly, Hardoi, and Faizabad, among others, seem greatly understated. Indeed, the Civil Surgeon of Budaun District estimated an annual incidence of 25 heatstroke cases in response to my questionnaire, while his office submitted a "nil" report to the D-GMHS. The Bulandshahar DMOH estimated a per annum rate of 50 heatstroke cases, while only one was officially reported. The Medical Officer-In-Charge, Amaria P. H. U. Dispensary, in Pilibhit District, stated "No report [i.e., none officially reported], but about 50 persons suffer from heatstroke every year". It is not clear whether this officer referred to the whole district or to his sub-division only, but a "nil" report was submitted by the Pilibhit District Civil Surgeon for the whole 1962-1966 period. This same gap between official reports and unofficial estimates extends through most of the questionnaires returned to the author from district medical officers. In some cases there is even serious discrepancy between the figures that were officially reported to the D-GMHS and the number of cases stated by respondents to my survey questionnaire as having been officially reported. At bottom, everything depends upon how conscientious the local and district medical officers were in recording and then in tabulating for purposes of the official surveys in 1962 and in 1966 the number of cases of hyperpyrexia and primary heatstroke which were treated.

Dr. G. S. Murty, formerly assistant epidemiologist of Uttar Pradesh, has suggested another complicating factor. He notes that in one recent year many cases of cerebral malaria in the Lucknow hospitals were not recognized at first and were officially recorded as heatstroke. Then when medical authorities came to realize the near-epidemic prevalence of cerebral malaria there was in turn a tendency for many genuine heatstroke cases to be misdiagnosed (Murty 1963). This may seem difficult to understand in view of other expert opinion that

> . . . since heat stroke is a rather marked pathological entity, mistakes in diagnosis based on autopsy findings are uncommon. (Bridger and Helfand 1968, p. 55)

But the post-mortem is not a routine procedure in rural India, except in cases of suspected foul play, and in practice the differential diagnosis of heatstroke in the Indian countryside remains a real problem, especially in respect to cerebral malaria (Gupta 1963, p. 119), but even pontine hemorrhage, idiopathic epilepsy, diabetic coma, uremia and acute febrile diseases as well (Minard and Copman 1963, p. 260). It is difficult, then, to avoid the conclusion that the map in Figure 7 above that purports to show heatstroke incidence may reflect, among other artifacts, significant factors of administrative efficiency or motivation! Up to the present, however, it is the best available to us.

Given the nature of official or registered medical statistics in North India, the most reliable approach to epidemiological data may lie in micro-studies carried out in limited areas such as hospitals. However, I have found only one such study pertaining to heat injuries in India in the medical literature, having to do with the experimental use of chlorpromazine in treating heat hyperpyrexia (Berry et al. 1961). Epidemiological aspects were incidental to the study and must be inferred. The trials were made at the Nagpur Medical College at Nagpur in Central India, about 300 miles south of Jhansi, U. P. During the period May 5 - June 8, 1959, 81 cases of heat hyperpyrexia were admitted to the hospital, of which 28 had a fatal outcome. The authors stated that the majority of cases were those who already had fever and were previously ill. Nevertheless, they found the etiological role of external temperature in the production of hyperpyrexia to be paramount, since such cases ceased as soon as the premonsoon external temperature fell, after June 8. Only 11% of the cases treated were those of genuine heatstroke defined as "sudden hyperpyrexia in a previously healthy individual". Infants under one year of age made up 61% of cases, while another 17% were in the 1 - 5 year age group.[1]

The period in question appears to have been one of average heat stress, with conditions roughly approximating those found during the hot season in U. P. Judging from this reliably reported incidence in Nagpur (or at least in the principal Nagpur hospital), a great difference in heat morbidity and mortality rates is obtained depending on whether heatstroke or heat hyperpyrexia is defined strictly or broadly. In the former sense, 9 officially reported cases of heatstroke in a city of 540,000--assuming no other cases were recorded by government clinics and dispensaries in Nagpur--would be equal to 108 cases in all of U. P., compared to the actual 5-year average of 456 reported cases. On the other hand, Nagpur's well-verified 28 deaths from hyperpyrexia in a broad sense is a reported rate of 0.05 per 1000 population, and this rate in U. P. would project to an annual total of about 1240, far more than the average of 66 fatalities that were actually reported.

As a rule of thumb, presumably based on good practical experience, the governmental medical services in India attach considerable importance to the sound principle that large numbers of heat casualties occur only after a heat wave has continued for three or four days. Indian climatologists have shown special interest in describing persistence phenomena, and in one recent study of temperature persistence phenomena in Gorakhpur (in eastern U. P.), 6 out of 25 years were shown to contain "hot spells" of 9 or more days in the month of May, the longest being one of 16 days (Tikkha 1962). Here a "hot day" was defined as one in which the maximum temperature exceeded the normal monthly maximum by at least one standard deviation. More recently, Raghavan has assembled all the statistical data for analyzing severe heat waves in India, defining as a "heat wave" any day in which the maximum temperature is at least 8 C.^{0} (14.4 F.^{0}) above normal. According to this study it is Kashmir which has the greatest incidence of heat waves.

---

[1]Probably most infant heat deaths in India, as in Australia, are really due to dehydration. The lassitude which occurs with dehydration often prevents infants from demanding liquids, and after dehydration they are likely to vomit milk (Macfarlane 1964, p. 49).

But Kashmir is a temperate region, and heat injuries are infrequent there. Otherwise, on the whole Indian subcontinent it is eastern U. P. which has the maximum incidence of heat waves--an average of one a year. While the average heat wave lasts only two or three days, maximum durations of 8 days are on record for both western and eastern U. P., and 10 days for Bihar. The longest heat wave on record on the Indian plains was 12 days, in June 1926 in Orissa state. This was also the most severe heat wave on record in terms of elevation above normal (22.5 F.°), a fact that is consonant with the author's cautiously-worded conclusion that

> The longer the stay of a wave, the more intense it may turn out to be. (Raghavan 1966, p. 586)

The special danger of the month of June for heatstroke incidence in North India is shown by Raghavan's monthly breakdown of heat waves: 18% in March, 7% in April, 11% in May, 54% in June, and 10% in July (Ibid., p. 584). Thus, not only is June the hottest month, at least in the western part of the North Indian plains,[1] but it is also the month with greatest likelihood of any given day's temperature maximum exceeding that day's normal maximum by more than 14.4 F.°--a function, of course, of the extreme variability in time of onset of the monsoon. A more sophisticated utilization of heat wave or thermal stress persistence concepts should eventually provide us a better understanding of the distribution of heat injuries in time and space, in North India and elsewhere.

D. The 1966 Bihar Heat Wave: a Case Study

In June 1966 parts of eastern U. P. and most of Bihar fell victim to a severe heat wave, resulting in a very large number of heat casualties. In September 1966 I visited Patna, capital of the state of Bihar, in the hope of obtaining as much quantitative data as possible on the medical effects of the heat wave. In this I was largely unsuccessful, but the following description of the course of my investigation may provide a useful case study of the problems which typically beset medical epidemiologists in North India.

---

[1]See Thompson 1958, Figure 4.

The overall picture of the 1966 heat wave is best given by reports appearing in the daily newspapers of the area, especially in the Indian Nation (Patna) and Searchlight (Patna), as well as the Northern India Patrika (Allahabad), National Herald (Lucknow) and Pioneer (Lucknow). In its feature article, "Heat Wave--a Study", the Northern India Patrika on June 1, 1966 pointed out that the term "heat wave" is strictly applied by Indian officials to conditions where the maximum temperature is 110° F. or more and where it also exceeds the normal temperature by 9 F.° or more.[1] It stated that heat waves are usually produced ". . . when the ground is subjected to prolonged heating by an overhead sun, and the air thus heated stagnates instead of being carried away sufficiently quickly". However, since this part of India had enjoyed relatively mild summers during the past few years (i.e., 1961-1965), the writer of this feature story opined that

> The present hot spell may be treated as an attempt by Nature to compensate the earlier temperature deficiencies, as is usually the case. (Northern India Patrika, June 1, 1966, p. 3)

For the period May 1 - June 5, the Patna weather was only slightly hotter than normal (May 1966 average daily maximum of 104.7° F. as compared to May normal daily maximum of 103.6° F.[2] However, 220 miles to the west in Allahabad newspapers were complaining on June 2 that for the past two weeks

> Blazing heat during day and windless, suffocating heat at night have made it difficult for them to keep life going. (Northern India Patrika, June 2, 1966, p. 1)

During the course of the previous two weeks' heat wave a new record maximum temperature for the month of May of 117.1° F. had been recorded at Allahabad. However, this heat wave did not prove to be

---

[1]This definition differs from that of Raghavan, but is similar to one adopted by the biometeorologists Sargent and Zaharko (1962, p. 179): (1) a deviation of the dry bulb by 8 F.° above normal; (2) an average daily mean dry bulb at least equal to the normal maximum temperature; and (3) a night temperature in excess of 75° F. Phillips (1897) found that numerous heatstroke deaths occur when these three conditions are met.

[2]These values are derived from the Central Meteorological Office's Five Day Normals and the Indian Daily Weather Report for May and June 1966.

very lethal, mainly because nighttime temperatures remained at relatively pleasant levels, allowing people to recoup their vitality somewhat at night. In addition, the record daytime heat killed most of the mosquito population, thus further improving outdoor sleeping comfort.

However, a worse heat wave was yet to come. It appeared on June 6, and for the next 8 days the average daily maximum temperature in Patna was 12.6 F.^{0} above normal (112.3^{0} F. as compared to 99.7^{0} F.), reaching a peak of 116^{0} F. on June 9. In Allahabad the standing all-time record temperature was equaled on June 8 with a reading of 118.8^{0} F. and broken on June 9 with 119.1^{0} F. On both dates the hot lū wind blew day and night, but relative humidity was low (18% at 0830 and 7% at 1730 on June 8). The minimum night temperatures were 88.5^{0} F. on June 8, 96.4^{0} F. on June 9, and 92.1^{0} F. on June 10.

The severe heat wave affected plants and animals as well as men. The combination of a week of temperatures in the 115^{0}-120^{0} F. range with a hot dry wind which blew throughout the day at speeds up to 25 knots caused mangoes to shrivel and fall, while the maize (planted early in parts of Bihar) became completely withered and yellow. Market gardeners of vegetables in the vicinity of cities saw the yield reduced by about 30%; in the case of Patna this amounted to a loss of 1600 tons of vegetables valued at Rs. 400,000. Casualties were heavy among livestock. Most of the poultry in the area died, as is usually the case at these temperature levels. Many thousands of cattle perished; there is no way of estimating the number.[1]

The Patna Searchlight's glaring front-page headline on June 12 ("WHOLE BIHAR LIKE A BLAZING FURNACE") fittingly describes the human condition in Bihar, where over 300 heat fatalities were officially reported, although it is almost certain that several times that number actually occurred. About June 1 the first heatstroke deaths in Bihar received newspaper attention. In Allahabad also the first heatstroke death of the year was described in the June 1 issue of the Northern India Patrika. The heat wave became a front-page story on June 8, when the searing hot lū wind blew until late in the evening. On

---

[1]Relatively heat-adapted though the Zebu cow of India may be, it is still susceptible to heatstroke. Das Gupta (1945, Vol. II, p. 508) details the symptoms.

June 9 about 100 cases of "sunstroke and dehydration" in the Patna area were reported. Water taps went dry in most part of the city after midday. The maximum temperature was 116° F. in the city, but was only 113° at the aerodrome.

On June 10 the news of scores of deaths throughout the state began to pour in. These local reports were generally accompanied by the comment that many more heat fatalities had occurred which went unreported. The temperature at Bhabhua (in Shahabad District near the eastern U. P. border) was placed at 123° F., according to the newspaper. In Mokameh (50 miles east of Patna) the victims, about six in all, were children. The report from here stated that diarrhea and vomiting cases were common. In Patna there was an electric power break at midday, causing distress to office workers.

On June 11 temperatures ranging from 112° F. to 120° F. continued over Bihar. Prominent among the victims of heatstroke were infants and children, as well as individuals whose work or activities kept them outside: cartmen, coolies, postmen, rickshaw pullers, beggars, etc. In Bhabhua sub-division of Shahabad District all mail deliveries were halted, as "80% of the postal runners had serious attacks of sunstroke" (Indian Nation, June 13, p. 5). Workers in the Jharia coal fields near Dhanbad requested a liberalization of working hours after 20 heatstroke deaths occurred within 48 hours in this region.

By June 12 it was apparent that a shortage of drinking water was playing a considerable role in the high incidence of heat casualties and mortalities. Due to the previous year's inadequate monsoon, 90% of the wells had dried up in some areas. Pure drinking water was reported to be selling for the exorbitant price of one rupee a pitcher in Mokameh and at 25 n.p. in many other places. There was an acute water scarcity in Gaya, where wells were dry and the supply from taps was also in a bad state. Despite the record heat wave thousands of pilgrims--especially women--left their homes to journey to a popular religious fair, the Kali Puja Mela at Saran in Monghyr District. There 100 persons fainted and 7 died, with much of the distress attributed to a lack of water.

As they have always been in the North Indian summer, train passengers were especially vulnerable to heatstroke. Numerous accounts of deaths involved persons on railway platforms, those alighting and those waiting to catch a train. The following quotation, which appeared in connection with the 1960 heat wave in U. P., could be found mirrored in every respect in Patna six years later:

> People at the railway station, at the bus stand, even inside houses, were attacked by "loo" and died in minutes, before any medical aid could be given. (Northern India Patrika, June 21, 1960, p. 1)

In Biharsharif four women walking home together died in a village along the way. Even patients in the Biharsharif hospital found it difficult to obtain a glass of water, according to the Indian Nation (June 16, 1966).

On June 14 the newspapers arrived at an official total of 324 deaths in Bihar, but believed the actual number to be

> . . . many times higher as these go generally unreported in the countryside where the largest number of strokes occur and even in towns where no records are kept after sunset. (Indian Nation, June 14, 1966)

Throughout the heat wave roads and markets were generally deserted between 10 a.m. and 5 p.m., as people remained indoors. Newspapers continued to note that "people were passing sleepless nights", and it was reported that heat collapses were occurring even at night. But at least one individual survived an awesome ordeal, according to the Indian Nation:

> The hero of the heat wave in Patna is a disabled mendicant who to the amazement of all stayed on at his post on the over-bridge like a rock fully

fully exposed to the sizzling heat all through the day and night. (Indian Nation, June 15, 1966, p. 3)[1]

It is probably impossible to say whether the number of heat fatalities in Bihar during this heat wave was under 400, as officially reported, or whether it was closer to 4000 or even more. The number of non-fatal heat disorders can be even less accurately estimated. According to one newspaper account, local doctors in Nawadah (1961 population: 17,468) estimated having seen 500 cases of "sunstroke" (apparently, heat hyperpyrexia) from June 7 to June 11. These patients generally had about 105° F. body temperatures, according to the newspaper .

A correspondent for the Press Trust of India visited Bans Ghat, the principal burning-ghat for the city of Patna, on June 12 and filed a story on his observations. He claimed that the official cremation register there, in which the name, address, age, caste or occupation, and cause of death of every corpse brought to the ghāṭ must be entered, showed 62 deaths due to lū lagnā or heatstroke up to 6 p.m. However, the correspondent stated that the cremation register in Patna, as in other cities and towns, is closed at sunset, whereas between the hours

---

[1]This incident is remindful of the fact that there is a long tradition in India of religiously-motivated austerities or spiritual exercises which demonstrate a human (or superhuman) capacity to withstand or indeed to overcome environmental hardships. Some yogis or devotees show disdain of enormous heat by sitting or by hanging upside down surrounded on all sides by fires and gazing directly at the sun. These four fires plus the blazing sun give this classic ascetic exercise its name: pancāgni-tapa, or "five-fire austerity" (Ghurye 1953, p. 37). At the other extreme, my informants in Lucknow recollected a sādhu who often displayed his capacity to endure cold by sitting virtually naked on the banks of the Gomati River in the winter, pouring numerous buckets of cold water over himself. In the high Himalayas and especially in Tibet, the practice of tummo or voluntary hyperpyrexia is well known and highly developed (Nebesky-Wojkowitz 1957, p. 228; Tucci 1967, pp. 84-89). This is the yogic exercise or art of immensely enhanced internal production of heat, which enables its master to be warm and comfortable in the most bitter cold.

of 10 p.m. and midnight he himself saw 30 bodies brought in, 20 of whom the attending relatives stated were victims of "lū" or heatstroke. The supply of wood for cremation at Bans Ghat was nearly exhausted and the wood-seller stated to the correspondent that 400 bodies were burned on that day (June 12), of whom half were heatstroke victims, and 350 were cremated the previous day. The normal daily number of cremations at Bans Ghat was said to be between 30 and 40. Finally, on June 13, 29 more heatstroke victims were cremated up to 4 p.m.

So much could be gleaned from newspaper accounts. During the course of a week's visit in Patna in September 1966 I attempted to correlate the wide range of estimates pertaining to the heat wave casualties. First, the officials at the Bihar Directorate-General of Medical and Health Services informed me that their records were very incomplete,[1] but that the total of heatstroke deaths officially reported in the June 1966 heat wave might be estimated at 300 to 400. Recognizing the inadequacy of the system of official medical reporting, they admitted that the actual number of deaths may have been somewhat higher, and indicated that the only way to determine the true heatstroke incidence would be to study it on the spot at the local level.

I then went to the Patna Medical College Hospital, by far the largest and most modern hospital in Bihar. The hospital has no central registry; rather, each ward (Medical Male, Medical Female, Pediatric, Surgical, etc.) keeps its own records. These records were essentially those released to the newspapers at the time: a total of some 80 cases of heatstroke with 31 fatalities, over two-thirds of both being in the Pediatric Ward. When asked about the huge discrepancy between the hundreds or thousands of cases indicated in newspapers and the mere 18 heatstroke admissions and 4 deaths in the Medical Male ward, the Registrar of this ward suggested that probably most victims died before being admitted to the hospital and that in some cases they were probably registered on admission under other categories, such as cerebral hemorrhage. Senior hospital (and government medical) officials generally

[1] This refers to the requests that had been circularized to local medical officers, as described in the previous section relating to Uttar Pradesh, to provide data to answer the Parliamentary Questions. Bihar districts are much larger than those of U. P. and the system of medical administration and reporting also differs in structural details.

denounced the press for exaggeration and sensationalism, behind which they detected political motives. One doctor even felt that heatstroke cases were fewer in 1966 than in 1965, except among children and in the city, and noted that when there is a shortage of water farmers stay home and rest instead of going out into the fields. He believed that the number of lū deaths was exaggerated in order to dramatize the water shortage (see Postscript below). Indeed, an opposition (Socialist) Member of Parliament made the statement, reported in the Searchlight on June 17, that "Malnutrition is the ultimate reason behind sunstroke deaths", apparently seeking to pin blame on the economic policies and administration of the dominant Congress party.

However, I made some discreet inquiries among "housemen" or interns and other subordinate employees in the hospital, and these produced a rather different opinion, one which indicted the authorities for systematic and willful underreporting of heatstroke casualties. While they were unable to provide precise estimates, these lower-ranking doctors and medical aides who were on duty in the Medical Male and Medical Female wards during the June heat wave stated that the wards were "filled with patients" suffering from heat disorders.[1] They believed that the true number of cases in the hospital was several times the 80 or so reported and felt that there was some vested interest in hiding heat casualties by registering them under other categories.[2]

Needless to say, this was quite explicitly the viewpoint of the Press Trust of India representative in Patna when I visited his office. He and the reporter who had been at Bans Ghat on June 12 reaffirmed the

[1]It can be truthfully said, however, that the wards are always filled with patients, and there is usually an overflow into the corridors and verandahs.

[2]Subsequently, a staff doctor at the Varanasi Civil Hospital confirmed this tendency on the part of hospitals to avoid the recording of heatstroke cases as such for purposes of official record. She noted that newspapers tend to publicize and sensationalize heatstroke casualties. And since the hospitals, as part of the official medical establishment, naturally do not hanker for unnecessary public criticism, they have adopted a pattern of listing many if not most heatstroke deaths as due to "fever", "hyperpyrexia", etc.

accuracy of their reporting, insofar as it was based on actual observation, accused the government officials of always trying to minimize the human misery resulting from natural catastrophes, and were certain that the number of deaths from the heat wave throughout the State was at least ten or twenty times that officially reported.

Still unable to resolve the discrepancies in estimates of the heat wave's medical effects, I sought out the medical officer of the Patna Municipal Corporation, who is responsible for the registries of deaths at the burning-ghats, as well as the collection of vital statistics within the Corporation limits through the normal channels.[1] I was assured by this officer that the burning-ghat registers are not closed at 6 p.m. (in Patna, at least), as alleged by the press, and that no corpse can be cremated at the <u>ghāṭ</u> without necessary registration. In response to my observation that many of the villagers conveying corpses to the <u>ghāṭ</u> are illiterate and could not fill out the register, he assured me that there is always some literate person there to take down the information.

My paramount interest of course was in seeing the Bans Ghat cremation register for the month of June 1966. However, the information was soon elicited from the head clerk that this particular register was not available. Early in August it had mysteriously disappeared, having been stolen at night from the custody of the Dom[2] in charge of it at Bans Ghat. I was told that the Corporation would prefer charges against him for his presumed dereliction of duty in not safeguarding it. (His predecessor was discharged for exactly the same reason a few years earlier.) However, the registers for other months and other years were searched out for me to examine. While these registers would constitute documents of considerable interest and significance to a social scientist, they appeared to be anything but reliable sources of medical

[1]The family head is required by law to notify the local Sanitary Inspector when a birth or death occurs in the family.

[2]Doms are the caste of untouchables whose traditional duty is arranging the funeral pyres and cleaning and maintaining the burning-ghats. Although ritually despised by high-caste Hindus for their occupation, the extent to which they monopolize an essential service has led to an enviable degree of economic well-being among at least some Dom families.

statistics. In June 1965, 265 cremations were recorded at Bans Ghat, of which 5 were described by the relative in attendance as due to "lū" (in one case by the English word "heatstroke" written in Nagari script). One of these was a woman aged 103! The June 1963 and June 1964 registers were not available, having been signed out for use as evidence in court cases. In June 1962 none of the 170 registered cremations was attributed to lū, while in June 1961 two of 207 were so recorded. Needless to say, most of the reasons listed as cause of death were vague: "fever", "old age", etc.

Incidentally, with respect to the missing cremation registry, I am reasonably certain that no one was simply trying to keep evidence from me. Something of the condition of local vital statistics reporting in India in recent years has been graphically described by two Indian researchers:

> All vital statistics in India seem to be painfully collected every year, but the greater part of the record disappears without trace. Inquiry from the lowest to the highest sources shows that most local registers vanish after a few years, or at least are not to be found whenever an investigator wishes to trace them. (Kosambi and Raghavachari 1951, pp. 169-170)

Perhaps with greater prudence than the present author, Kosambi and Raghavachari conclude: "Specific examples are necessarily omitted to avoid unpleasantness"! Theft and destruction (or more often alteration) of official records are indeed rather common in North India, and the cremation register provides prime evidence in the local courts in relation to the inexhaustible flood of litigation arising out of land disputes, inheritance, and criminal actions.[1]

The Patna Municipal Health Officer did have the official death records for the city, derived from the normal reporting channels. These official death statistics, tabulated by age-group, for June 1966 are:

---

[1] I do regret having failed to ask one relevant question: just why did and do the municipal authorities allow so important a document as the cremation register to be kept for 3 months at the burning-ghat, rather than requiring it to be turned in at shorter intervals?

Reported Deaths in Patna, Bihar in June 1966 (by Age-groups)

	0-1	1-4	5-9	10-14	15-19	20-29	30-39	40-49	50-59	60+	Total
M	44	21	35	17	17	24	19	15	14	5	211
F	26	15	12	10	13	11	12	20	12	5	136
T	70	36	47	27	30	35	31	35	26	10	347

While the age distribution of mortalities in Patna in June 1966 can be seen to contrast strikingly with that found in Western countries, it is fairly close to North Indian norms. Thus, if the above totals are converted into percentages, they can be compared with what were in 1966 the most recently published two-year averages for urban Bihar (9.3% of which is made up by Patna) as follows:

Percentages of Deaths by Age-group

	0-1	1-4	5-9	10-14	15-19	20-29	30-39	40-49	50-59	60+
Patna (June 1966)	20.17	10.37	13.54	7.78	8.65	10.09	8.93	10.09	7.49	2.88
Urban Bihar (1959-1960)[1]	18.03	13.46	5.28	3.73	3.85	7.98	8.24	8.29	9.45	21.68

It can be noted that deaths in the 5-19 age groups were much higher than normal in Patna in June 1966, while deaths in the over-60 age group were even more strikingly reduced in number. The nature of any effect of the 8-day heat wave in producing the apparent divergence in June 1966 from the long-term norms of deaths by age-group in urban Bihar is not at all clear, but we should presume that it did have some effect.

In the brief time remaining to me in Patna I was able to make an early morning visit to Bans Ghat and was fortunate in locating Shri G., the Dom registrar, who readily produced his battered, grimy cremation register for the then current months of August and September 1966.

[1]Source: Health Statistics of India (Years 1959 and 1960)

They showed 762 cremations during these two months. Shri G. did not appear particularly discomfited by the fact that charges and the threat of dismissal were pending against him; probably the office provides its holder more headaches than rewards anyhow.

Upon questioning, Shri G. was unable to say exactly how many cremations took place at Bans Ghat for the month of June 1966 or during the heat wave. However, he held that even on the worst day there were certainly no more than 100. After talking to Shri G., I visited the nearby area where firewood for cremation purposes was being sold. The wood-seller was not present, but a Panda Brahman, or priest who plays a part in death observances on the Ganges bank, denied that large numbers of people died of lū in the June heat wave. At first he said that there were only 15 or 20 cremations a day at that time, then admitted that on the worst day there may have been 60 bodies cremated. He noted that the newspaper reporter might have observed a large number of corpses at night because during the hot season the relatives or caste-fellows who carry or accompany the body from their home--often from rather distant villages--arrive mostly at night and early in the morning, since they are disinclined to travel in the heat of the day.

Valid comparisons of course cannot be made between (1) the June 1966 official Patna death statistics and (2) the number of cremations at Bans Ghat. (Indeed, their relative degrees of accuracy or completeness are uncertain.) Some of the deaths included in the first but not included in the second are those among the city's non-Hindus--a small minority of Muslims and Christians--who are buried rather than cremated. More important, the Bans Ghat register does not include (1) Hindus dying in the city but cremated at one of the two other (much smaller) burning-ghats; and (2) Hindus cremated illegally or placed in the river without cremation. The number of the latter might in fact be sizeable, and it especially includes infants, who are the most vulnerable to heat effects. Cremation--even if it is virtually a token burning and the mainly unconsumed body is simply pushed into the Ganges--is essential in Hindu dharma. But since firewood sells at the rate of Rs. 3 to 4 per maund (82 lb.), and about 8 maunds of firewood are required to cremate thoroughly an adult corpse, the cost of cremation is prohibitive for many people. One solution may thus be an essentially surreptitious proceeding which goes unrecorded in the register.

But while the government's law may be readily circumvented, society's cannot be. After a Hindu is cremated it is obligatory for the family to observe a number of rituals including the provision of a feast for kinsmen, another burdensome expense for most impoverished families. Therefore, in the case of deaths of children under five (and in practice perhaps some even older), the body is almost always carried to the Ganges and placed in the water without ceremony.[1] No death rituals are required in this case, nor will the names appear in the Dom's register. The same is true of the seasonally numerous smallpox and cholera deaths (attributed by villagers to the wrathful Mother Goddess, Bhagavati Mai), for these victims are also committed directly to the Ganges without cremation, although in the case of adults the death rituals are observed at some future date, with the symbolic cremation of a small "corpse" molded of flour and water (see Planalp 1956, pp. 632ff).

Conversely, there are deaths which are included in the Dom's register but not in the official Patna vital statistics. These are the deaths of villagers from up to 30 miles or more away, whose relatives are anxious to have them cremated on the banks of the sacred Ganges itself and therefore bring them to Bans Ghat rather than to a local burning-ghat situated on some minor stream. A very cursory examination of the Bans Ghat cremation registers indicated that about half the names entered there were from outside the city of Patna.

However inconclusive are my final estimates of the heat casualties resulting from the heat wave of June 1966, it is at least certain that they were at a rate many times that of normal years and, more surprisingly, several times that of neighboring U. P., where even higher temperatures prevailed. Thus, for the 8-day period June 6 - 13, the Patna-Gaya area averaged maximum and minimum temperatures of 113.2° F. and 85.6° F. while those of the Allahabad-Kanpur area some 270 miles west were 114.3° F. and 89.2° F.[2] At the time of the official

[1]This is true if the family lives near the Ganges or other river. If not, small children are simply buried in the "jungle" or under the mud bank of a pond.

[2]These values were obtained by averaging figures for Patna and Gaya and for Allahabad and Kanpur, as reported in the Indian Daily Weather Report for the period indicated.

5:30 p.m. observation, temperatures averaged 108.9° F. with a relative humidity of 15.9% at Patna-Gaya and 110.1° F. with a relative humidity of 16.6% at Allahabad-Kanpur. Despite the fact that the June heat wave produced greater heat-stress conditions in eastern U. P. than in Bihar, only 71 deaths from heatstroke were reported in U. P., an incidence of less than one-eighth of that in Bihar. The divergence is probably to be explained on two grounds: (1) water shortages in Bihar were widespread, and physiological dehydration greatly increases the susceptibility to heat injury (Minard and Copson 1963, p. 358); and (2) although dry and wet bulb temperatures in U. P. were higher than those in Bihar, their departure from long-term normals was greater in Bihar.

Postscript

Even as I was attempting in September 1966 to explicate the dimensions of the heat wave which had occurred 3 months previously, a vastly larger tragedy was in the making. Monsoon rains had been subnormal for the past two years, and now the late monsoon precipitation of September, so utterly essential to germination of the winter crops, was failing completely, thus producing the worst drouth in over 100 years.[1] This set the stage for the terrible Bihar famine of 1966-1967, in which only massive grain shipments from outside the state and from outside India kept the final death toll under a million rather than in the tens of millions.

Arthur Hopcraft[2] was in Bihar in March and April of 1967, six months after my visit there, at a time when two-thirds of the state's 50 million population barely maintained existence at the starvation level. His rather sharply critical descriptions of Patna (". . . often named as the dirtiest city in India . . .") and its labyrinthine bureaucratic inefficiency and squalor, mirrored vividly to me the conditions under which during one crowded week I had pursued my own--by comparison, relatively trivial--problem:

---

[1]Exactly the same situation in the same area 70 years previously produced the 1896-1897 famine in Bihar and U. P., called the most disastrous of the century until the famine of 1899-1900 came along to be accorded the same description (Bhatia 1963, p. 239).

[2]Born To Hunger (Boston: Houghton Mifflin, 1968)

> Its government offices reflect all the state's worst aspects . . . In these rambling buildings there is an unbroken babble of voices. The corridors are thronged with messengers lounging or ambling about, ejecting streams of betel-stained spittle into spittoons the size of orange crates, and humping piles of cardboard files tied up in tape. Any conversation I had with an official below the most senior rank was conducted in fits and spurts in a welter of interruptions. It was not at all unusual to have an interview in front of two, three or four uninvolved listeners who came in and sat around the desk. Clerks shambled in with bits of paper to be signed. The wind gushed dustily through the windows, and doors banged. No one seemed to be concentrating on any one subject for more than a couple of minutes. The scene looked unlikely to produce sound administration, and plainly it had not. (Hopcraft 1968, pp. 119-120)

State elections, courageously carried out in January 1967 in the midst of the famine, resulted (as the Press Trust of India reporters had predicted) in a vote of stinging popular dissatisfaction with the party in power. Some billion and a half rupees had been spent in Bihar over the previous 15 years for improvement of irrigation and water supplies, "with results so minuscule that they could only be accounted for by a system of graft and corruption so entrenched as to be virtually coterminous with the administrative network", in Hopcraft's view.

> This does not mean a few men stacked away huge fortunes in filched public funds; it suggests rather that a great many people dipped regularly and modestly into the till. I am not stating this lightly. It was put to me firmly by a variety of people, in a position to know, that corruption had developed an established pattern in Bihar. (Ibid., p. 117)

Of course, public concern about the problem had already produced a new and large government bureau known as the State Anti-Corruption Board--an impressive roster of 47 names and telephone numbers in the 1965 Patna Circle telephone directory, taking up half a page out of a total of only 68 pages. Incidentally, when I suggested to Indians that the Anti-Corruption Board might be an effective step in the direction of reducing graft in government, they were greatly amused at such naivete. On the contrary, they pointed out, such a proliferation of more Secretaries, Deputy Secretaries, Additional Secretaries, Under Secretaries, and so on, along with their administrative and clerical appendages, vastly magnifies the scope for corruption, for now an additional group of officials exists to be bribed to drop charges, to instigate false charges, and so on![1]

Hopcraft believes that the shock of an electoral upset, together with the actual famine crisis, resulted in the digging of more new tubewells and the building of more irrigation works in a few months of 1967 than were accomplished in the previous 15 years. At any rate, this is the background of bureaucratic torpor and of economic catastrophe within which the small case study of epidemiological investigation just described should be viewed.

E. Heat Stress and Comfort in North India

While the number of heat morbidities, even those of a transient order, seldom reaches more than a small proportion of the heat-acclimatized population exposed to a severe summer heat wave, everyone certainly experiences feelings of discomfort. Actually, "discomfort" is merely the lowest threshhold of heat strain, and the attempts to measure it are part of the whole evolution of approaches to the quantitative assessment of heat stress and its resultant physiological strain (see Appendix C).

"Comfort" and "discomfort" are subjective psychological states, and no single objective measurement has been found to be a reliable substitute, although physiologists once hoped that skin temperature

---

[1]In case any reader assumes that systematic corruption is confined to such distant and underdeveloped regions as Bihar, he is advised to read the feature article in the <u>Wall Street Journal</u> of Nov. 29, 1970, which documents the extensive patterns of bribery which exist in New York City. It quotes a sociologist as saying: "Corruption is one way of making a social system work. In effect you're paying for services rendered". In India, too, analysis that is more than superficial suggests that ". . . those actions which the modern world stigmatizes as nepotism and corruption, are in fact often the fulfilling of a man's obligations in the traditional world" (Bailey 1967, p. 36).

might so serve. It has generally been assumed that heat discomfort as such makes no contribution to the onset of the recognized heat injuries--heatstroke, heat exhaustion, or even heat syncope. But one experienced observer holds that

> Continued exposure over a period of years to a level of stress which never exceeds that of mere discomfort may be the basis of the so-called tropical neurasthenia. (Macpherson 1958, p. 38)

And Ellis recognizes that prolonged service in an unduly warm climate will invariably produce the psychological and physiological symptoms of "hot climate fatigue" among at least some healthy young men (Ellis 1952, p. 531). The incidence of "tropical fatigue" may well be related to individual differences in heat comfort ranges and discomfort threshholds, and certainly to factors of attitude and motivation. Unresolved questions abound in this murky medico-psychiatric zone of tropical neurasthenia. Napier, for example, observes that

> Discomfort depends much upon previous experience and mental attitude. It has been noted that the more highly educated are more likely to resent heat, while others accept it as inevitable. (Napier 1943, p. 11)

However, Macpherson concluded rather differently from his observations of "tropical fatigue" among military forces in New Guinea and the East Indies:

> There is no place in the tropics for the poor in spirit. Added to this there must be an adequate education, to provide a variety of interests, and a congenial and worthwhile job to provide the incentive for activity. Those fit only to be the hewers of wood and drawers of water are sure to fail . . . (Macpherson 1949, pp. 144-145)

He found, in fact, that "psychological deterioration" was generally related inversely to rank (and to educational level) in the troops he studied.

As indicated in Appendix C, over the years a good many studies have been made, using the popular Effective Temperature Scale, with a view to comparing different populations, or the same population at different times. A general pattern of seasonal and climatic adaptation emerges from these studies, although they also reveal a good many contradictory findings, which are probably attributable mostly to slight variations in technique (Macpherson 1964, p. 213). In the United States the earlier investigations (prior to 1940) showed an optimum comfort point of about 66° F. ET (in the winter),[1] while in more recent studies the comfort point has risen to 68° or even 70° F. ET. This is probably due to the lighter clothing being worn (and perhaps the increased level of indoor heating) in the U. S. A. In England, a country where central heating is much less important and where there is a preference for wearing woolen clothing, the optimum comfort temperature is 63° F. ET--and as low as 60° F. ET in winter (Bedford 1948, p. 97; Macpherson 1960, p. 203). There is a rather consistent tendency for the subjectively-preferred temperature to rise about 3 F.° ET in the summer in temperate zones, while it is also at all times about 3 F.° ET higher in southern cities such as Washington, D. C. and San Antonio, Texas than in the northern cities of New York, Toronto and Minneapolis (ASHRAE 1965, p. 112). Upper limits for comfort (for lightly clad persons, and in the summer), which may be taken as about 3--5 F.° ET above the optimum comfort point, have been stated by Wyndham to be only 68° F. ET in the U. K., but 76° in the U. S. A., 77° in Calcutta, 78° in Singapore, and 81° in parts of Malaya and northern Australia (Wyndham 1964, p. 192). So far as the natives of the North Indian plains are concerned, the upper comfort level has generally been placed at 78° or 79° F. ET (Murgai 1951; Malhotra 1955). More specifically, Mookerjee and Murgai have determined that a Corrected Effective Temperature of 77 (° F.) is the average upper comfort level for Indians at the beginning of the hot dry season, when they are unacclimatized. This critical point moves upward to 79° upon acclimatization and, for those accustomed to outdoor work, to 81°. A CET index reading of over 87 is "intolerable" (Mookerjee and Murgai 1952, p. 15). Malhotra notes that in the summer the optimum comfort

[1]The Effective Temperature (ET) index numbers cited in this section, unless otherwise specified, are in terms of the "normal" or lightly-clothed scale, rather than the "basic" (shorts without shirt) scale.

zone for Indian sailors in tropical uniform is 76° - 79° F. ET, and that upper levels of comfort are generally about 1 F.$^{\circ}$ ET higher for Indian subjects than for British subjects acclimatized to heat in the tropics (Malhotra 1955, p. 473).

The above data appear relatively consistent, and there is a goodly body of anecdotal corroboration of the following sort:

> . . . the indigenous Nigerian shivers and feels miserably cold during the Harmattan, even in Southern Nigeria, while the European continues to go round in shorts and shirt. (Ladell 1955, p. 17)

I have seen a similar published observation--although the source now eludes me--of the cold-weather behavior of troops from India who were serving as part of the United Nations peacekeeping forces in the Suez Canal area some years ago. In marked contrast with their Scandinavian counterparts, the Indian soldiers shivered and complained of the cold. At the same time, the two following quotations will amply illustrate some of the perplexities which plague the whole matter of scientific evaluation of comfort sensation:

> . . . the only time I have found a summer in Britain too hot was on leave from Nigeria. One notices in India that it is often Indians who feel the hot weather most. (Ambler 1966, p. 279)

> . . . the loudest complaints about the Calcutta weather have come, not from his European but from his Indian colleagues. In an investigation on the "comfort zone" in a bank in Shanghai, it was found that the comfort zone of the Cantonese clerks was lower than that of the European members of the staff. (Napier 1943, p. 18)[1]

dry bulb

[1]Noting that the winter indoor/temperature in Britain has risen in the past 25 years from about 61° F. to 68° F., and in the U. S. A. from 68° F. to 77° F., Glaser has recently commented on the paradoxical nature of thermal adaptations in a high-technology urban world: "Offices in New York in winter are already warmer than offices in Singapore or Hong Kong during the hottest part of the year, because cold places are becoming hotter and hotter as heating and insulating technology improves and warm places are becoming cooler and cooler as air conditioning gets better. One wonders where this will end, but . . . it is unlikely that it should improve health and efficiency." (Glaser 1970, p. 68)

Macpherson (1964) has recommended that comfort surveys rigidly define "comfortable" as thermally neutral, neither too warm nor too cool, rather than continuing to use the confusing terms "comfortably warm" and "comfortably cool". In a very carefully conducted study in Sydney, Australia, it was found that even at the optimum comfort temperature (73^0 F. ET), 20% of the population was not "comfortable", 10% being too cool and 10% too warm (Hindmarsh and Macpherson 1962, p. 336). And the very large range of individual variation in human thermal comfort response is shown by the fact that at 65^0 F. ET some people were already warm, and at 81^0 some still felt cool!

It is no wonder that a question of high psychological component, such as comfort, is subject to so much uncertainty since even the physiology of acclimatization is far from being well understood. Edholm, for example, in 1966 reported on a study in which a group of heat-acclimatized Indian subjects (mostly fit young men) flown from Lucknow to London at the end of September were tested against comparable unacclimatized British subjects, both two days after arrival and again in January after both groups had been subjected to a 2-week heat acclimatization regime. The surprising finding, which the author was unable to explain, was: "One would conclude that the British subjects were better acclimatised to heat than the Indian subjects" (Edholm 1966, p. 22).

Sargent and Zaharko also draw attention to the puzzling cases which continue to occur, in which men who are considered heat-acclimatized (after a supervised 3-week regime) nevertheless suffer serious or fatal heat illnesses at levels far below what have been recommended as safe (Sargent and Zaharko 1962, p. 191). They and other authorities now believe that full acclimatization to heat may actually require 8 weeks or more, rather than 3 weeks as usually supposed.

> . . . one experiment at Singapore on a group of young men indicated that physiological adaptation was not yet complete after exposure for five months for four hours a day, six days a week, to standard work in a hot environment. (Ellis 1962, p. 527)

Yaglou, in fact, is cited as having suggested that additional heat acclimatization may accrue up to perhaps 10 years (Sargent and Zaharko 1962, p. 191).

My questionnaire, described in the previous pages, directed to the U. P. Civil Surgeons and District Medical Officers of Health, asked these officials for an opinion as to the month in which the most uncomfortably hot days occurred. Eight of 15 respondents went on record as finding the most uncomfortable days of the year in June, while four named August, two July, and one September. I also interviewed some 28 people in Varanasi, seeking to compare attitudes and reactions to the hot dry summer season of May and June with those to the hot humid season of August and September. The two kinds of heat stress are clearly perceived by North Indians, who refer to the summer climate as sukhī garmī ("dry heat") and to the sultry late monsoon climate as sarī garmī ("'rotten', moist heat").[1] Roughly half of my informants considered the worst days of the ṣarī garmī to be more uncomfortable than the worst days of the sukhī garmī, but the interviews were made in September and October, which may have had some effect on the results. Out of 28 respondents to this question, approximately 4% indicated in the course of interviews that the most uncomfortable days for them personally occur in May, while 30% stated June, 14% July, 22% August, and 20% September.[2] Incidentally, there are substantial settlements in Varanasi of Panjabi immigrants from the more arid west, and of Bengalis from the damper climate to the east. The former almost uniformly complained most about the sultry periods, while the Bengalis found the hot dry season more unpleasant. In the only investigation that I have found in the literature that is comparable to this, Wyndham in Australia concluded that the hot dry season is disliked slightly more than the wet monsoon period (Wyndham 1962, p. 534). However, the climatic regimes of North India and of Australia are not fully comparable.

I was not able to discern any significant sexual difference in opinion as to the month or time of severest heat discomfort, since only eight respondents were women. Just as the exact nature of acclimatization is still a matter of expert disagreement, so is that of sex differences in relation to the physiology of heat. In a classic study, Hardy and Du Bois

---

[1]Even more commonly, villagers use the term umas ("sultry or moist heat") to refer to this season. But there does not seem to be a single-word equivalent for the heat of the dry or desert-like season.

[2]All except four of my informants framed their opinions in terms of the Hindu lunar months (see p. xi), and I have therefore adjusted the verbatim responses accordingly.

(1940) concluded that women are able to reduce their basal metabolism under exposure to heat 14% to 20% below the reduction achieved by men, probably as a result of endocrine differences.[1] Despite this, the skin temperatures of women were found to be 3 F.° higher than those of men, a characteristic which permits increased heat loss and a reduction of heat gain. Hardy and Du Bois found that women did not commence sweating below 90° F., while men began to sweat at an environmental temperature of 84° F.

> They did not need to sweat as soon or as much because they had lowered the production of heat in their bodies. (Hardy and Du Bois 1940, p. 392)

The individual points of optimum comfort for a female sample population extends over a range of 11 F.°, as against a range of only 5 F.° for a comparable group of men. The interesting corollary to this, however, is that women are also more sensitive or susceptible to thermal discomfort, for at the average optimum temperature a higher percentage of men than of women are comfortable. On average, women's optimum comfort temperature is 1 F.° ET higher than that of men, and that of both sexes over the age of 40 is 1 F.° ET higher than that for persons below 40 (Bruce 1960, p. 75).

Considerable evidence, and certainly a broad spectrum of lay opinion, has been quoted in the preceding pages to document the idea that many factors and irritations, other than high temperature alone, contribute to a total picture of heat discomfort in India. Among them are glare, dust, noise, insect pests, and skin diseases, most of which further increase sleeplessness--and hence, in a vicious circle, produce a lower threshhold of discomfort. We might take as an example the sleeping under a mosquito net (still an essential protection in much of North India) inside a pakkā house in a city. The net reduces air movement over the sleeper from 80 ft. per minute to 10 ft/min (Crowden 1949, p. 340). Since air velocity at thermal neutrality is usually imperceptible under 100 ft/min (Ellis 1952, p. 423), this is a degree of stagnation which has the effect of increasing the temperature by about 2 F.° ET. Due to the stored heat in roof and walls, the temperature inside the room at night may remain from 5 to 10 F.° above that outdoors. Considering these incremental factors, therefore, conditions of "intolerable" heat discomfort can exist for many people at a much lower level, and over a longer period of the year, than might be obvious from ordinary climatological records.

---

[1] The BMR of women is almost exactly 7/8 of that of men of the same height and weight (Quenouille et al. 1951, p. 14).

LIST OF REFERENCES

Agarwala, K. S. 1960. "Local variations of air temperature at Delhi", Indian Journal of Meteorology and Geophysics, Vol. 11, pp. 276-278

Ambler, H. R. 1966. "Conditions of thermal comfort in North India", Journal of Tropical Medicine and Hygiene, Vol. 69, pp. 275-281

American Society of Heating, Refrigerating, and Air-Conditioning Engineers. 1965. ASHRAE Guide and Data Book for 1965 and 1966. Fundamentals and Equipment. New York: ASHRAE

Ashmore, Harriette. 1841. Narrative of a Three Months' March in India. London: R. Hastings

Bailey, F. G. 1967. "The peasant view of the bad life", Science and Culture, Vol. 33, pp. 31-41

Banerji, S. C. and Siddhu, C. M. S. 1965. "Study of the factors and attitudes of medical officers working at Primary Health Centres in Uttar Pradesh", Indian Journal of Medical Sciences, Vol. 19, pp. 789-794

Barber, Noel. 1965. The Black Hole of Calcutta. Boston: Houghton Mifflin Co.

Bedford, Thomas. 1948. Basic Principles of Ventilation and Heating. London: H. K. Lewis and Co.

Berry, J. N., Subhedar, B. J., and Bhargava, H. S. 1961. "A controlled trial of chlorpromazine in the treatment of hyperpyrexia", Journal of the Association of Physicians of India, Vol. 9, pp. 747-757

Bhatia, B. M. 1963. Famines in India. New York: Asia Publishing House

The Bible

Bose, U. K. 1966. Personal communication

Brass, Paul R. 1965. Factional Politics in an Indian State. Berkeley: University of California Press

Bridger, C. A. and Halfand, L. A. 1968. "Mortality from heat during July 1966 in Illinois", International Journal of Biometeorology, Vol. 12, pp. 51-70

Browne, E. G. 1935. "Deaths from excessive heat in Kansas", Public Health Reports, Vol. 50, pp. 546-548

Bruce, W. 1960. Man and His Thermal Environment. Ottawa: National Research Council, Canada. Division of Building Research

Chandler, T. J. 1967. "London's heat island", pp. 589-597 in Vol. II, Part 2, Biometeorology (Proceedings of 3d International Biometeorological Congress, Pau, S. France, 1-7 September 1963) (S. W. Tromp and W. H. Weihe, eds.)

Chandra Sekhar, A. 1970. "Registration of births and deaths in India", Swastha Hind, Vol. 14, pp. 271-272

Chaudhuri, Nihal. 1965. The Continent of Circe. London: Chatto and Windus

Collier, Richard. 1964. The Great Indian Mutiny. New York: E. P. Dutton and Co.

Cock, Edgar L. 1955. "Epidemiological approach to heat trauma", Military Medicine, Vol. 116, pp. 317-322

Crowden, Guy P. 1949. "A survey of physiological studies of mental and physical work in hot and humid environments", Transactions of the Royal Society of Tropical Medicine and Hygiene, Vol. 42, pp. 325-340

Das, P. K./ 1968 The Monsoons. New Delhi: National Book Trust, India

Das Gupta, Satish Chandra. 1945. The Cow in India. Calcutta: Khadi Pratisthan (2 vols.)

Davis, Kingsley. 1951. The Population of India and Pakistan. Princeton: Princeton University Press

District Gazetteers of the United Provinces of Agra and Oudh. Vol. XVI. 1909. Banda: a Gazetteer. Allahabad

_____. Vol. XXXVIII. 1903. Unao: a Gazetteer. Allahabad

Edholm, O. G. 1966. "Acclimatization to heat in a group of Indian subjects", pp. 20-25 in Human Adaptability to Environments and Physical Fitness (M. S. Malhotra, ed.). Madras: Defence Institute of Physiology and Allied Sciences

Ellis, F. P. 1952. "Hot climate fatigue in the Royal Navy: a review of lay opinion", Lancet, Vol. 263, pp. 527-531

_____. 1955. "Prevention of heat incapacitation in the armed forces", Military Medicine, Vol. 116, pp. 323-329

Ellis, F. P. 1962. "Some thoughts on needed research in tropical climatology to promote the health and working capacity of tropical populations", pp. 526-528 in Tropical Health. Washington, D. C.: National Research Council. National Academy of Sciences

Ferguson, Matthew J. and O'Brien, Sister Michael Marie. 1966. "Heat illness--the neglected disease", Medical Times, Vol. 94, pp. 897-902

Fleming, Peter. 1961. Bayonets to Lhasa. London: Rupert Hart-Davis

Gauss, H. and Meyer, K. A. 1917. "Heat stroke: report of one hundred and fifty-eight cases from Cook County Hospital, Chicago", American Journal of Medical Sciences, Vol. 154, pp. 554-564

Geiger, Rudolf. 1965. The Climate Near the Ground. Cambridge: Harvard University Press (4th ed.)

Ghurye, G. S. 1953. Indian Sadhus. Bombay: The Popular Book Depot

Glaser, E. M. 1970. "External protection of man against meteorological extremes", pp. 65-70 in Biometeorology, Vol. 4, Part I (S. W. Tromp and W. H. Weihe, eds.). Amsterdam: Swets and Zeitlinger N. V.

Goldsmith, J. R., Oechsli, F. W., Hexter, A. C., and Buechley, R. W. 1970. "Excess mortality in California associated with high temperature", p. 74 in Biometeorology, Vol. 4, Part II (S. W. Tromp and W. H. Weihe, eds.). Amsterdam: Swets and Zeitlinger N. V.

Gordon, Charles A. 1857. "Observations on the statistics of diseases of the brain and nervous system. as they affect soldiers, officers, women, and children in India", The Medical Times and Gazette, Vol. n.s. 15, pp. 416-417

Gordon, Thomas Edward. 1906. A Varied Life. London: John Murray

Gupta, S. P. 1963. "Acute heat reactions and their management", Punjab Medical Journal, Vol. 13, pp. 117-122

Hardy, James D. and Du Bois, Eugene F. 1940. "Differences between men and women in their response to heat and cold", Proceedings of the National Academy of Science, Vol. 26, pp. 389-398

Hearne, K. G. 1932. "Hyperpyrexial heatstroke: a Mesopotamian experience, with some aetiological views and a method of prevention resulting therefrom", Medical Journal of Australia, Vol. 1, pp. 226-232

Henschel, Austin and McPhilimy, Harry S. 1963. "Field test methods", pp. 315-345 in Environmental Physiology and Psychology in Arid Conditions. Reviews of Research. Paris: UNESCO

Hindmarsh, Margaret E. and Macpherson, R. K. 1962. "Thermal comfort in Australia", Australian Journal of Science, Vol. 24, pp. 335-339

Hodder, B. W. 1955. "Biogeographical aspects of settlement in Malaya", Malayan Journal of Tropical Geography, Vol. 5, pp. 12-19

Hopcraft, Arthur. 1968. Born to Hunger. Boston: Houghton Mifflin

India. 1961. Census of India, 1961

India. Meteorological Department. 1953. Climatological Tables of Observatories in India. Delhi

_____. 1955. Five Day Normals (of Pressure, Temperature and Humidity). Delhi

_____. The Indian Daily Weather Report

India. Posts and Telegraphs Department. 1965. Bihar Circle Telephone Directory. Patna: Regional Posts and Telegraph Advisory Committee, Bihar Circle

The Indian Nation (Patna)

Jelliffe, D. B. 1958. "Miliaria in Bengali children in Calcutta city", Transactions of the Royal Society of Tropical Medicine and Hygiene, Vol. 52, pp. 71-77

Kosambi, D. D. and Raghavachari, S. 1951. "Seasonal variation in the Indian birth-rate", Annals of Eugenics, Vol. 16, pp. 165-192

Ladell, W. S. S., Waterlow, Y. C., and Hudson, M. F. 1944. "Desert climate, physiological and clinical observations", Lancet, Vol. 247, pp. 491-497, 527-531

Ladell, W. S. S. 1955. "Physiological classification of climates", Proceedings of the International West African Congress. Ibadan, Nigeria, 1949. Jos: The Department of Antiquities

The Leader (Allahabad)

Lowry, William P. 1967. "The climate of cities", Scientific American, Vol. 217, pp. 15-23

Macfarlane, W. V. 1964. "Water and electrolytes of man in hot dry regions", pp. 43-53 in Environmental Physiology and Psychology in Arid Conditions. Proceedings of the Lucknow Symposium. Paris: UNESCO

Macpherson, R. K. 1949. Tropical Fatigue. Brisbane: University of Queensland Press

_____. 1958 "Heat tolerance", pp. 34-39 in Vol. VI, Proceedings of the Sixth International Congress on Tropical Medicine and Malariology, Lisbon, September 5 - 13, 1958

_____. 1960. Physiological Responses to Hot Environments. London: HMSO (Medical Research Council, Special Report Series No. 298)

_____. 1964. "Between-group differences in thermal comfort standards", pp. 213-219 in Environmental Physiology and Psychology in Arid Conditions. Proceedings of the Lucknow Symposium. Paris: UNESCO

Majendie, Vivian Dering. 1859. Up Among the Pandies. London: Routledge, Warne, and Routledge

Malhotra, M. S. 1955. "Environmental comfort zone in a warm and humid atmosphere", Journal of Scientific and Industrial Research, Vol. 14A, pp. 469-473

_____. 1964. "Salt requirements of acclimatized people during summer in the tropics", pp. 97-99 in Environmental Physiology and Psychology in Arid Conditions. Proceedings of the Lucknow Symposium. Paris: UNESCO

Manson-Bahr, Sir Philip H. 1965. Manson's Tropical Diseases. London: Bailliere, Tindall and Cassell (16th ed.)

Marsh, Frank. 1930. "The etiology of heat-stroke and sun traumatism", Transactions of the Royal Society of Tropical Medicine and Hygiene, Vol. 24, pp. 257-288

_____. 1933. "Further studies in 'heatstroke'", Transactions of the Royal Society of Tropical Medicine and Hygiene, Vol. 27, pp. 255-267

Mills, C. A. and Ogle, Cordelia. 1933. "Climatic basis for susceptibility to heat stroke or exhaustion", American Journal of Hygiene, Vol. 17, pp. 686-696

Minard, David and Copman, Louis. 1963. "Elevation of body temperature in disease", pp. 253-273 in Vol. III, Part 3, Temperature: Its Measurement and Control in Science and Industry (James D. Hardy, ed.). New York: Reinhold Publishing Corp.

Mookerjee, G. C. and Murgai, M. P. 1952. "A preliminary report on the determination of comfort zone of Indian subjects during North Indian summer", Journal of Scientific and Industrial Research, Vol. 11, pp. 14-16

Morton, T. C. 1944. "Heat effects in British service personnel in Iraq", Transactions of the Royal Society of Tropical Medicine and Hygiene, Vol. 37, pp. 347-372

Murgai, M. P. 1951. "Measurement of human comfort", Science and Culture, Vol. 16, pp. 543-545

Murty, G. S. 1963. Personal communication

Napier, L. Everard. 1943. The Principles and Practice of Tropical Medicine. Calcutta: Thacker, Spink and Co.

The National Herald (Lucknow)

Nebesky-Wojkowitz, Rene dé. 1957. Where the Gods are Mountains. New York: Reynal and Co.

Northern India Patrika (Allahabad)

Pai, D. N. 1965. "Epidemiology of accidents and other causes of violence", Journal of the Gujarat Research Society, Vol. 27, pp. 241-261

Phillips, W. F. R. 1897. "Meteorological conditions of sunstroke", Transactions of the American Climatological Association, Vol. 13, pp. 223-237

The Pioneer (Lucknow)

Planalp, Jack M. 1956. Religious Life and Values in a North Indian Village. Ph. D. Dissertation, Cornell University (University Microfilms No. 56-979)

Quenouille, M. H., Boyne, A. W., Fisher, W. B., and Leitch, I. 1951. Statistical Studies of Recorded Energy Expenditure of Man. London: Commonwealth Bureau of Animal Nutrition (Technical Communication No. 17)

Raghavan, K. 1966. "A climatological study of severe heat waves in India", Indian Journal of Meteorology and Geophysics, Vol. 17, pp. 581-586

Raina, Bishen Lal (ed.). 1961. Official History of the Indian Armed Forces in the Second World War 1939-45. Preventive Medicine (Nutrition, Malaria Control and Prevention of Diseases). Delhi: Combined Inter-Services Historical Section, India and Pakistan

Roberts, Field-Marshal Lord. 1901. Forty-one Years in India. New York: Longmans, Green and Co.

Sargent, Frederick II and Zaharko, Daniel S. 1962. "Medical-meteorological forecasting--an application of fundamental bioclimatological concepts", pp. 174-195 in Biometeorology (S. W. Tromp, ed.). Oxford: Pergamon Press

Schickele, Elizabeth. 1947. "Environment and fatal heat stroke", The Military Surgeon, Vol. 100, pp. 235-256

Schuman, S. H., Anderson, C. P., and Oliver, J. T. 1964. "Epidemiology of successive heat waves in Michigan in 1962 and 1963", Journal of the American Medical Association, Vol. 189, pp. 733-738

The Searchlight (Patna)

Shattuck, George C. and Hilferty, Margaret M. 1932. "Sunstroke and allied conditions in the United States", American Journal of Tropical Medicine, Vol. 12, pp. 223-245

_____. 1933. "Causes of death from heat in Massachusetts", New England Journal of Medicine, Vol. 209, pp. 319-329

_____. 1936. "Distribution of acute heat effects in various parts of the world", New England Journal of Medicine, Vol. 214, pp. 458-468

Simmons, James S. 1944. Global Epidemiology. Philadelphia: J. B. Lippincott (3 vols.)

Sinha, B. P. 1965. "Art of war in ancient India (600 B. C. - 300 A. D.)", pp. 115-163 in Studies in the Cultural History of India (Guy S. Metraux and Francois Crouzet, eds.). Agra: UNESCO

The Statesman Weekly

Taylor, J. 1919. "Meteorological conditions in Mesopotamia affecting the occurrence of heatstroke", Indian Journal of Medical Research, Special Science Congress Number, pp. 181-185

Thompson, Will F. 1958. Analogs of Canal Zone Climate in India and Southeast Asia. Natick, Mass.: Environmental Protection Research Division, Quartermaster Research and Engineering Center (Technical Report EP-91)

Tikkha, R. M. 1962. "Persistence probability of the spells of hot and cold days at Gorakhpur", Agra University Journal of Research. Letters, Vol. 10, Part II, pp. 69-80

Time. June 15, 1970, p. 26

Tromp, S. W. 1963. Medical Biometeorology. Amsterdam: Elsevier Publishing Co.

Wall Street Journal. November 29, 1970, p. 1

Willcox, W. H. 1920. "The nature, prevention and treatment of heat hyperpyrexia", British Medical Journal, n.s. Vol. 1, pp. 392-399

Wolfe, John N., Wareham, Richard T., and Scofield, Herbert T. 1949. Microclimates and Macroclimate of Neotoma, a Small Valley in Central Ohio. Columbus, Ohio: Ohio Biological Survey (Bulletin 41)

WHO Chronicle. 1964. "Heat illness", WHO Chronicle, Vol. 18, pp. 283-304

Wyndham, C. H. 1962. "Research needs in tropical climatology", pp. 533-540 in Tropical Health. Washington, D. C.: National Research Council. National Academy of Sciences

_____. 1964. "Performance and comfort standards in relation to climate", pp. 189-198 in Environmental Physiology and Psychology in Arid Conditions. Proceedings of the Lucknow Symposium. Paris: UNESCO

VII

CONCLUSION

"It is hardly ever possible to make any general statement about any subject in India without at once being confronted with facts which seem to prove that you are wrong . . ."[1]

It would be misleading to give the title of this final chapter a plural form, because it less a statement of conclusions than a series of restatements in conclusion. Hopefully, the present work has pointed to a number of interesting problems which lie in the fringe areas of overlap of anthropology, bioclimatology, tropical medicine, and Indic Studies, and it may have revealed some of their features and dimensions. However, this project has largely been approached in sympathy with the comment voiced by an eminent and sensitive anthropologist that

> . . . without a broadly based contact with personally perceived realities, the investigation of "problems" runs the risk of being merely a projection of the preoccupations of Western social science, which can be as ethnocentric as was Freudian psychology. (Du Bois 1970, p. 223)

So much of the published social scientific data on India (and alas! this seems equally true of the indigenous contributions) is highly cerebral, but at the same time somehow devitalized and cut off from its roots in the life-experience of ordinary people. It is often filled with abstract and specialized jargon and is at the same time arid and stultifying, so that one finds it refreshing to harken to the welter of down-to-earth facts and contradictions that make up the living reality of a country and a people. The varied fabric and the complex, even paradoxical, realities of Indian life have been somewhat mirrored in the occasional disorder of the preceding pages, which range over a veritable potpourri of matters involving both culture and climate in North India. To attempt to tie all these together, and to suggest what they may mean, should be the aim of this final chapter. Unfortunately, the questions are too intractable, the answers debatable.

---

[1]Henry Whitehead, The Village Gods of South India, p. 1^

There is surely broad agreement that the natural environment that surrounds a people, especially if it is an extreme environment, will eventually cast its reflection in many subtle ways on their health, their habits and customs, and indirectly their ideology and values. A number of observers have claimed a causal connection between the Indian climate and the presumed qualities of its civilization, especially a philosophical subjectivism, pantheism and supernaturalism, and a certain lack of energy in physical and practical endeavors.

> . . . the climate of the delta is somewhat enervating, the people are naturally prone to be lazy, easy-going and easily upset by reverses of fortune. (Chatterjee 1954, p. 407)

> India's ever-changing physical conditions and her all-pervading jungle have impregnated her way of thinking. . . . In the mainly tropical climate of India, with its never-resting, ever-changing dynamic phenomena . . . Nature holds its sway over the human mind and its imagination. (Heimann 1964, pp. 89, 107)

> India's peculiarly trying climate causes it to be haunted by epidemics and infectious diseases, and from these conditions results the extreme instability of human life which is reflected in the common Hindu outlook on human existence and forms the background of the pessimism voiced by the Hindu philosophers. (Edelstein, in Zimmer 1948, p. lviii)

Yet, as Basham notes, a people who could build great irrigation works, temples, and the like can hardly be considered devitalized, and

> If the climate had any effect on the Indian character it was, we believe, to develop a love of ease and comfort, an addiction to the simple pleasures and luxuries so freely given by Nature--a tendency to which the impulse to self-denial and asceticism on the one hand, and occasional strenuous effort on the other, were natural reactions. (Basham 1963, p. 13)

The Hindu ethos has often been described as encouraging "other-worldliness" and "passivity" in all spheres of social life. But so far as that most worldly sphere of economics is concerned, a modern economist has recently weighed the question as to what extent traditional values are obstacles to economic growth in India, and concluded:

> There is no single "Hindu"--and therefore no single Indian--ideological position to shape social behavior. . . . these [many strands of Hindu theology] could have been extracted and combined in a variety of ways to rationalize or stimulate a variety of economic behaviors ranging from the most passive and otherworldly to the most aggressive and profit-maximizing. (Morris 1967, p. 595)

It is true that Indian villagers are inclined to adopt a "fatalistic" attitude toward the rigors of climate and the ravages of Nature. Typically, they will shrug: "What can we do? This is all the 'naughty play' (prakōpa) of the Gods". But the educated elite of modern India, with their fervent pursuit of expertise in every possible scientific field from plant genetics to nuclear energy, and nowadays especially those fields having urgent practical importance, are surely activists rather than passive figures in the face of a frequently hostile natural environment. And still, there is no dearth of critics prepared to document a long-standing Hindu preference for airy theory rather than earthy application:

> I came to see that the abstract world is both more real, more valid and more prestigious than the workaday world, and that Indians are happiest when they dwell in it. And because the world of ideas is the real world, the higher world, there is a feeling that to enunciate a plan is to have executed its more important part. (Smith 1962, pp. 185-186)

Insofar as there may be an element of truth in these well-turned phrases, one is tempted to detect some indirect influence of a harsh environment at work.

Just as this is an argument that can be joined plausibly on either side, so too is the question of the extent and nature of any long-term deleterious biological effects of the North Indian climate on the men and women subject to its regime. So far as the immigrant or sojourner from temperate zones is concerned, we have already heard a fair sampling of the opinions of Europeans in India from 1700 up to recent times, and a few more can be added:

> Above all, the mental faculties deteriorate surely and rapidly in this hateful climate. (Trevelyan 1864, p. 202)

> . . . it has always been impossible to colonize the plains of India, as the second generation, or so many as survive childhood, are weak miserable creatures, destroyed in body and mind by the heat. (King 1884, p. 105)

> Man and beast languish and gasp for air, while even in the house, the thermometer stands between 95° and 115°. Little by little, the European loses appetite and sleep, all power and energy forsake him. (Kendrew 1927, p. 127)

Of course, the Anglo-India of Warren Hastings' or even of Kipling's time could not readily differentiate pathogenic from climatic effects, and as early as 1780 Mrs. Fay sensibly concluded that

> . . . you behold Europeans, languishing under various complaints which they call incidental to the climate, an assertion . . . respecting which I am a little sceptical, because I see that the same mode of living would produce the same effects, even in the hardy regions of the north. (Mrs. Fay, cited in Brown 1948, p. 22)

Today vaccines and antibiotics along with improved sanitation have largely reduced the tropics' pathogenic threat to the well-nourished, well-behaved European's health, and most modern scientists reach the same conclusion:

> We are trying to assess the effect of a hot steamy climate *per se* on human energy, when reasonably appropriate housing and dress are used. Our evidence indicates that human energy can be maintained at a high level under these conditions. (Wulsin 1949, p. 66)

> . . . the heat and damp of the tropics cannot be proved to have by themselves a great effect on the European, since he can live, work with his hands, and beget strong children in a tropical climate. . . . A white people could flourish in a hot, wet region were it quite healthy, were there no natives, and were the soil of lasting fertility. (Gourou 1953, p. 113)

But the conditions that Gourou sets exist scarcely anywhere in combination, and he seems to have quite ignored the psychological threats inherent in long-term, unrelieved tropical living.

Manson-Bahr, one of the great eminences of tropical medicine, has recognized the importance of the cumulative effects of heat-related stress factors, none of which might perhaps be critical if taken separately:

> Tropical life may have a disturbing effect on the mentality of even the most healthy and balanced individual. After a year or more of constant exposure to heat and humidity, the hours of sleep become disturbed, and the nervous system more sensitive to external stimuli. Insomnia may be precipitated by certain electrical conditions of the atmosphere, at present little understood, skin conditions, especially prickly heat, and possibly a hyperglycaemia which Dutch investigators in Java ascribed to the climate. (Manson-Bahr 1965, p. 580)

Fletcher enumerates at least 20 tangible external and internal factors that can contribute to heat stress, without even touching on the multitude of psychophysiological irritations and torments whose totality may in fact tip the balance between effective survival or non-survival in the tropics (Fletcher 1966, p. 29).

As one example of these, we may cite the vicious ãndhī (Bhoj. ãnhī) or dust-storm on the North Indian plain

> To some people even a mild dust storm acts as a special irritant. Hot dry winds, combined with dust, are reported in certain areas to drive susceptible people insane, and whether one considers that this could be an adequate stimulus or not, the mere prevalence of the belief makes it possible. (Lee 1958, p. 112)

Eighty years apart, both Mrs. King and Nihal Chaudhuri have recorded their special exasperation that every metal object in the house, even at night, can burn the skin if touched during the hottest days in North India.

So far as my personal experience is concerned, the difficulty of obtaining restful sleep probably ranks at the top of the hot-weather irritations, exactly as Wyndham emphasized in connection with his Australian studies (Wyndham 1962, 1964). A major problem is that, even if one can escape the suffocating, heat-retaining rooms to sleep outdoors, it is precisely at the hour of the most pleasant coolness that India's crows and dogs become boisterous (Lyon 1954, p. 101). But among the plentiful assortment of sleep-destroyers are: dust-storms, mosquitoes (or lack of breeze under mosquito netting), bedbugs, roving snakes and scorpions, and in some circumstances one's fellow-men.[1]

Extraneous stresses aside, however, those who have resided in India often claim for the heat there some quality of uniqueness, of special intensity which eludes quantification, and can never quite be captured in any meteorological profile:

> Everyone who has been in India, and also in Africa and Australia, knows that, owing to some peculiarity of the atmosphere, heat is felt much more in India than the same degree of heat in Australia would be. (King 1884, p. 104)
>
> The heat is extreme. It is something that only those who have experienced it can fully realize. (Thornhill 1899, p. 18)
>
> Even after living in the country for thousands of years the Hindus have not got used to the heat. . . . Even I, in spite of my climatological philosophy, go

[1] I was disturbed one night in a respectable, well-patrolled government-operated hostelry in New Delhi by a scratching sound at my pillow, and came awake just in time to have a fleeting glimpse of a long stick being withdrawn through a barred window. Such incidents underscore the important role of the night-watchman, or "chowkidar", in Indian life.

> half mad. . . . All this might sound like high-flown rhetoric to those who have not lived on the great north Indian plain, but certainly not to those who have. The virtues of understatement are not for the men who know it, and it is an affectation to be surprised at extremism in a land of extremes. (Chaudhuri 1965, p. 136)

As to those who are truly indigenous to India, whose ancestors for centuries have known no other climate, some of the facts of their adaptation to the environment are obvious: their clothing, their houses, their pigmentation, their unhurried work regime. Yet, it is not simply the climate that has shaped these responses as we see them today. It is also a chronic and still scarcely diminished poverty. It is true that obese individuals are markedly more vulnerable to heat injury (Schickele 1947, p. 245), and Burridge regarded the lean, thin Indian physique as a perfect adaptation to the hot climate (Burridge 1944, p. 19). However, the principal reason one cannot count more than a handful of even moderately robust individuals--none of them obese by American standards--out of a thousand adults in a North Indian village is that the average adult male's daily food intake is less than 2500 calories (even when agricultural operations are strenuous).[1]

Basham, as we have seen, believes the climate has inculcated a "love of ease and comfort" in Indians. Others have echoed the sentiment in less flattering terms:

> . . . humidity and heat have sapped people's energy and made manual work extremely unpleasant. Indeed, tropical climate has helped to make distaste for manual labor a deep tradition. (Frykenberg 1968, p. 12)

> . . . they are provokingly slow in execution. This, however, is a characteristic of the races of India generally. The Hindu is slow in all his movements. (Sherring 1872, p. 341)

[1]A random sample of 72 adult males in Madhopur in eastern U. P. was measured and weighed in 1954. Their average height was 5 ft. 8 in. and average weight was 112 lb. The tallest man was under 5 ft. 10 in. and the heaviest weighed 144 lb.

> The unbroken flatness of the plain finds its counterpart in dullness of the mind, monotony of experience, and narrowness of interests. With this climate and physiography is combined a diet which is so highly adapted to the environment that it is as fatal to creative energy as the other two. Starch seasoned with spices is the typical food of the Indo-Gangetic plain, and it is capable of nurturing no other forms of human activity or outlook on life than what possesses its own insipidity. (Chaudhuri 1951, pp. 502-503)
>
> Anything done by Indians, with the possible exception of clerical work, is done at a snail's pace. I have been with Siamese, Malayan, Chinese, Annamite and Palestinian Jewish bearers; we only needed the third of their number in our mess and camp. A merchant requires an Indian complement three times the size of one manned by any other Asiatic race. Every mess and hut is crowded with bearers standing around chattering and yawning. To see them all over the camp, lazing, slouching and squatting is absolutely infuriating. There is no getting away from it they are fundamentally lazy people, and their main aim and object is to do as little as possible. (Hagen 1946, p. 57)

However, one might also conclude that the inhabitants of the Gangetic plains have simply always practised what the modern medical bioclimatologist latterly proclaims:

> . . . one of the best ways to avoid heat disease is to keep the body hydrated and avoid exercise. (Sargent and Zaharko 1962, p. 189)

And in the same vein, much of the European's chronic irritability in the tropics may be less attributable to the climate than to his unavailing attempts to have his local employees or underlings put forth as much work as those of temperate zones (Dill 1938, p. 94). Kipling has an oft-quoted and apropos stanza:

Now it is not good for the Christian's health
To hustle the Aryan brown,
For the Christian riles, and the Aryan smiles
And he weareth the Christian down;
And the end of the fight is a tombstone white
With the name of the late deceased,
And the epitaph drear: "A Fool lies here
Who tried to hustle the East" (Kipling 1919, p. 603)

However, matters are not so simple. For one thing, we now know that much of the cause of the chronic lack of energy that may be perceived among many indigenes of the tropics is to be found in the quantity of parasites in their bodies. And after all is said and done, despite the excellent climatic and medical justification for physical torpor on the part of North Indians, the feats of exertion that some of them--for example, the perspiring, hunger-driven rickshaw-wallahs--can be seen performing on even the hottest of summer days quite put to shame the crumpled lethargy of most long-resident foreigners (especially when these constitute, as they so frequently do, the burden which the former are pulling). Mrs. Das has described how American missionary ladies rested in their cool stone rooms between 10 and 4 on hot days, fanned by punkah-wallahs, having paid local Indian women to walk 2 or 3 miles to and from the bazaar in the broiling sun to visit Hindu women and talk to them about Christianity (Das 1930, p. 119). Similarly, the physiologist Burridge has feelingly described the contrast between his own acute distress one warm day in April when his ceiling fan was suddenly halted by a power failure, and the absence of any sign of heat discomfort whatsoever in his old bearer after the latter had rushed to his rescue and hand-fanned him vigorously for some time (Burridge 1944, p. 5).

The nature and dynamics of the cultural and behavioral adaptations of a people to their physical surroundings constitute matters of some theoretical interest to anthropologists. The culture and the life-way of a people, arrived at over centuries of "trial and error" in a given environment, should constitute a successful, if complex, set of adaptations to that environment. But simple physical, climatic, or geographical features do not themselves determine culture, for there are too many examples where, at different points in history, rather markedly contrasting cultures have flourished in the same locale.

> California was the most backward part of North America when the continent was inhabited exclusively by Indians. Now that the palefaces have taken over, California has been called many things, but not backward. Yet the climate . . . has undergone no detectable change. (Bates 1952, p. 125)[1]

It is a good and debatable question how closely the traditional culture of North India, within its limits of technological resources and knowledge, approximates an objective or rational optimum of adaptation to the environment, and specifically to the thermal environment. We have seen above how the Madrasi settlers in New Delhi retain a climatically inappropriate house-type and manner of living during the summer months. D. H. K. Lee long ago noted a "foolish tendency" among Europeans in the tropics to copy cooler-climate housing features which seem stylish or attractive, even though they are quite unsuitable to a hot tropical environment (Lee 1944, p. 2). Chaudhuri (although he can be accused here of playing fast and loose with ethnological facts) makes a blanket charge of North Indian climatic maladaptation:

> But all over northern India, living in a country subject to the monsoons, men built as if they were still in the Middle East. They never carried out any adaptation to the climate and weather. Their huts are still made of sun-baked clay, with a stiffening of lath. The roofs are flat, and they are often of mud and wattle. The villages are nucleated, and in them the houses stand shoulder to shoulder in rows separated only by narrow and miry lanes . . . (Chaudhuri 1965, p. 138)

---

[1]Still, it ought to be significant that all the world's early civilizations evolved near the 70° F. average temperature isotherm. And is it only coincidence that the surge of Western civilization did not occur until the use of the chimney spread throughout northwestern Europe in the 13th and 14th centuries, thus providing a comfortable microclimate? (Sohar 1970, p. 101). As one indication of the backwardness of the hot regions of the earth--whether due mostly to climate or mostly to the accidents of political history--a map of the world's universities as of 1937 shows that less than 1% of them were located within the tropics, where half the world's people live (Ibid., p. 101).

One wonders how he would have had them construct their houses and villages, given the resources available and the historical insecurity of life in the countryside.

A team of physiologists, architects, and biophysical engineers today could no doubt recommend a number of obvious steps which the residents of a typical North Indian village might take to improve their comfort in the hot season. Thus, Givoni found in Israel that simply whitewashing the red roof tiles would lower the indoor temperature near the ceiling by 5 F.° at the time of maximum temperature, at 3 p.m. (Givoni 1962, p. 243). Similarly, studies made of thermal conditions within the mud dwellings in northern Nigeria (whose walls, like those in North India, are about 36 inches thick), led to the conclusion that mud walls could be reduced to 10 inches in thickness with virtually no loss of insulation against midday heat, while at the same time greatly improving indoor night comfort through the lower thermal capacity of the walls (Peel 1958, p. 203). One may also cite the tradition among Arab women (and among some Muslim women of northwestern India) of wearing everyday garments of black, the very least suitable color when exposed to solar radiation in a hot environment.

> . . . it has been pointed out that a man exposed to the sun may have a solar radiant heat load of 250 kcal/hr cut in half by wearing full, white clothing. (Lind 1964, p. 174)[1]

It is probable, however, that only a few of the obvious recommendations for reducing thermal stress that might be made by a visiting team of environmental scientists uninformed about sociocultural factors could in fact be readily implemented in the actual ongoing context of the Indian village. The suggestion that mud walls should be only 10 inches thick, for example, would be greeted with derision in this area where heavy monsoon rains can crumble even the 3-ft. walls unless they are well protected by matting. Villagers would also be quick to remark what a boon a 10-in. mud wall would be to that type of anti-social element known in North India as the cupcāp cōr, the silent burglar who digs through house walls in dead of night to reach family valuables.

---

[1]And 125 kcal/hr is a significant heat load--two or three times the basal metabolic rate (Tromp 1963, p. 408).

So far as the wearing of black clothing is concerned, there is even the possibility here that a little scientific knowledge is as bad as none at all, for no less an authority than Renbourn has recently postulated that

> For those who because of convention cannot wear light-coloured clothes under the tropical sun, there is some consolation in the thought that (apart from a specific effect of the chemical nature of a dye) there may be somewhat less physiological difference between a white and black suit of the same material and design than is generally believed. This may be explained in terms of scattering and internal reflection of solar energy unabsorbed by the surface yarns. (Renbourn 1962, p. 97)

The boon of whitewashing stone roofs is well appreciated in North India, but in the case of the red roof tiles its impermanence and the difficulty of renewal are deterrents, while high indoor ceilings reduce the differential thermal effects.

And so it goes. In any event, one should not, in his concern with the extreme heat threat in the North Indian environment, forget that houses and clothing here must also provide protection against a winter seasonal cold stress whose severity may be belied by temperature records.

> All buildings in Delhi are constructed with immensely thick masonry walls, to keep out the heat. But in winter they keep the cold in, and it is like living in a damp cavern. (Trumbull 1957, p. 50)

> . . . introduced to brick houses with little or no artificial heating, many an American newcomer has suffered more from cold during his first winter than ever before in his life. (Thoburn 1946, p. 120)

This is, in my experience, an often-repeated statement made by visitors to North India. In fact, William Crooke once remarked that North Indians do not dread the fierce sun, or the hot dry season, as do European sojourners:

> To him [summer] is about the most pleasant and healthy season of the year, and people who are sometimes underfed and nearly always insufficiently dressed have more reason to fear the chills of December and January than the warmth of May and June. (Crooke 1968, p. 315)

Hill, who found a marked decrease in the rate of suicides and violent crimes in U. P. in the winter (about half the maximum rate, which occurred in August and September), even surmised that

> . . . any one who has been in India in the cold weather and seen to what an abject condition the ordinary native is reduced by a temperature of 60° or so can believe [that] . . . about 48° crimes of violence would disappear, for at such a temperature nobody would possess a sufficient store of energy to enable him to commit crime of any graver description than petty larceny. (Hill 1884, p. 340)

In the preceding chapters it has been apparent that there are areas of human bioclimatology in India which cry for scientific attention. One is the determination of actual heat stress and heat strain in specific microclimates, in the range of actual conditions in which any given individual lives and works. Another need is to understand the nature and dynamics of longer-term and cumulative effects of heat stress, while a third is the assessment of differences between severe hot-dry and hot-humid environments.

Of course, the Indian villager has long been aware on an empirical basis of the heat strain increments deriving from wind, sun, dust, glare, and so on, and has adjusted his behavior accordingly. But it is for the scientist to calculate more precisely the impact of albedo, reflectivity and absorptivity, long-wave and short-wave radiation and re-radiation, and all the other phenomena which have significance as environmental parameters. The various typical situations of heat stress in the North Indian urban and rural milieus and their norms and ranges have simply not been defined and quantified, except in such isolated industrial sectors as textile mills and gold mines, even though this is well within the technological capability of modern environmental instrumentation. But even further from ready assessment are the combined impact of the measurable environmental stresses and those proceeding from internal and from less tangible external causes.

A theme that has appeared again and again through this study is the existence of two separate and distinct periods of heat stress in North India--that of the fiery desert-like summer and that of the sultry latter half of the monsoon. It cannot be stated with any certainty which of the two is more "intolerable", and the likelihood is that the answer to this question is greatly dependent upon individual susceptibilities.[1] Primary acute heatstroke, the most dramatically lethal form of heat injury, is almost entirely limited to the former season, with its excessive dry bulb temperature and its lū winds. Still, the resident of North India may be intermittently or occasionally subject to severe heat stress at any time during more than six months of the year, and it seems that heat discomfort, heat fatigue, and heat neurasthenic reactions are often greater in August or September than in May and June. So great is the accumulation of debilitation and discomfort by this time that I found almost exactly half of my informants in Varanasi today agreeing with L. S. S. O'Malley, a man who knew the country intimately, that September along the eastern marches of North India is

> . . . the most trying period of the year, as the sodden soil lies reeking under a scorching sun, and the air is still heavily charged with moisture; even the Bengalis, habituated as they are to sultry heat, call this month "the rotten month". (O'Malley 1917, p. 67)

Mrs. Ashby, born and raised in Bihar, also singled out this season above all others in her remembrances:

> A lull during the monsoons is stifling almost to the point of suffocation. The sun rises scorchingly hot from the moment it clears the horizon. The grass and fields of grain, watered to a wholesome greenness but a week before, may be wilted in a few hours. . . . The sticky atmosphere keeps us in a bath of perspiration. All I can do is sit here under a punka on the verandah. (Ashby 1937, p. 231)

---

[1] In this respect, matters seem little changed from the time of Mrs. King, who found herself unable to weigh in the balance (1) the summer period when the air ". . . heats the bath-towels till they make me gasp as I dry my face!" and "My head often feels as if it were being fried and all night long I keep it and my pillows well sopped with cold water" and (2) the ". . . stewing heat for the next three months at best--a perpetual Turkish bath, which makes the skin soft, and brings prickly heat to torment one with its sharp stabs . . ." (King 1884, pp. 106-109).

In the last analysis, however graphic and persuasive the first-person accounts of typical summer season and typical late-monsoon season heat stresses, the epidemiological data on heatstroke in North India point to the one time above all others when man is most vulnerable to environmental heat. It is that time described by an old-time resident of the Panjab:

> At length, in June, the hot winds cease to blow, and are followed by a calm; and now indeed the heat is truly fearful; grass screens and thermantidotes avail naught . . . (Kendrew 1927, p. 128)

That is to say, the absolute apex of environmental heat stress in North India is found whenever, just before the onset of the monsoon, the western <u>lū</u> winds cease and are replaced by calm or by the moist east wind, when skies are not yet filled with the sun-shielding dark rain clouds, and when the dry bulb temperature remains over 110° F. but the humidity rises. This is precisely the meteorological association alluded to by Lee and described by him as "well-nigh unendurable", which on a worldwide basis is most frequently encountered along the southwestern coasts of the Persian Gulf and of the Red Sea, but which also appear intermittently in India, in Australia, and north of the Gulf of California. Only in occasional years, fortunately, are there several consecutive days of this kind in North India, sufficient to bring the number of heat fatalities into the thousands. Significantly, Lee concludes that

> . . . neither the incidence nor the physiological effects of these conditions have been studied in full detail . . . (Lee 1963, p. 63)

Despite such ingenious studies as that of Sen (see p. 439), tropical physiology and biometeorology have barely begun to enlighten us with respect to the comparative stresses of hot-dry and hot-wet regimes. Wyndham is among the few who has addressed himself to this question, concluding that, in the long term, the tropical regime of sultry days and uncomfortable nights has a more severe effect on inhabitants than the desert regime of excessively hot days but relatively cool nights. Yet, he is forced to admit that

> As far as is known no quantitative studies have been made to determine the relative effects of these two different climatic conditions on human reactions. (Wyndham 1962, p. 534)

Some brief attention has been focused in this work on the bioclimatological and epidemiological implications of the seasonal North Indian fluctuations in morbidity, mortality, and conception rates. Because of the multiple causation which must be assumed for these vital statistics, few problems offer such challenge to inter-disciplinary research, since factors relevant to the fields of physiology, of anthropology, of psychology, or climatology, and of medicine are all involved. So far as seasonal fluctuations in conception rate are concerned, we should expect that the current intensive Indian research-cum-action assault on population control will produce much new knowledge.

We have seen in the preceding chapter that many questions pertaining to the epidemiology of heat injuries in North India also remain unanswered. In the first place, there has been relatively little official concern with heat effects as a major public health hazard[1]--not surprising in a country where vastly larger numbers of people are affected by ailments far more susceptible of reduction by governmental programs of prevention and cure. The reporting of medical and vital statistics in India is extremely unreliable, as authorities there are the first to admit, and the existing reporting schedules do not clearly and uniformly differentiate heat effects. The present paper has attempted to utilize the ad hoc statistics of heatstroke and heat exhaustion in Uttar Pradesh, as gathered through the official channels, but the results unfortunately are predicated on very dubious basic data.

In relation to heat disorders in North India the evidence, fragmentary and ambiguous as it is, points to an increase over time in absolute numbers and probably (although here we cannot be so certain) in per capita incidence as well. The relationship of dietary adequacy to heat illness incidence is a rather indirect one, but insofar as chronic malnutrition contributes to an individual's susceptibility to fevers of various kinds, to skin disorders, and so forth, to that extent he is more vulnerable to environmental heat than would otherwise be the case. And in this respect there is scant evidence of much improvement in recent years.

---

[1]In 1964--I believe for the first time--the U. P. Health Education Bureau distributed 10,000 copies of a small, attractively-printed orange-colored leaflet entitled Garmī yā Lū Lagnā ("Heat or Lū Stroke"), which described the symptoms of heatstroke and the best methods of prevention and cure.

It may be urbanization and industrialization that largely account for what a majority of local North Indian medical officers take to be an increasing rate of heat illnesses. The stresses of an urban inflexibility of work schedule, such as is little known in the village, and the suffocating congestion and poverty of the urban slums, no doubt take their toll. There is, however, another factor likely to predispose to higher incidences of heat fatalities in the future. That is the steadily increasing life expectancy, which has risen from 35 years to 52 years within the past two decades, due to improvement of medical and health services. Heat mortality has a high correlation with age, the very old and the very young being the most vulnerable. For comparison, the average age of 291 heat deaths in Kansas in 1934, excluding 14 infants, was 71 years (Belding 1962, p. 1053). As the age pyramid of the Indian population begins to shift upward, an increase in deaths attributable to heat waves will be likely.

The overwhelming majority of North Indians believe and in fact insist--although there seems to be no independent evidence to support the claim--that they reduce their salt intake in the hot season. But this may indeed be true, and at the same time have no adverse effects, for Malhotra believes that

> . . . under very hot environments reaching 110° F. dry-bulb and 144° F. globe thermometer Indians could maintain their salt balances on a dietary salt intake of 16 g/day. (Malhotra 1966, p. 349)

After all, very low intakes--perhaps as little as 3 to 5 grams daily, or the same as the normal cool-climate non-stress requirement--have been reported in several tropical African countries (Schreider 1963, p. 61; Sohar and Adar 1964, p. 59). The existence of clinical evidence that high chloride sweat concentration (and, therefore, high salt intake) is a contributing factor to the development of prickly heat, might serve to offer some logic for a reduction in North Indian salt consumption in the summer. However, popular beliefs do not seem to explicitly link the two phenomena.

A number of informants indicated to me that in Bengal more salt is used in food and drinks than in U. P., and this rather impressionistic view accords with the National Sample Survey findings that average daily salt intakes range from a high of 24 grams in the perpetual hot climate of southern India to a low of 14 grams in parts of northern India (M. S. Malhotra 1964). The Indian Salt Department's massive and authoritative work also documents a downward gradation in salt usage (which may not necessarily be the same thing as salt intake) from coastal southern and eastern India in a north-northwesterly direction, attributing the difference primarily to relative moistness of the climate and to patterns of rice- and fish-eating (Aggarwal 1956, p. 394).[1]

A final aspect of the relationship between thermal environment and North Indian health ideology and behavior that deserves some attention is the matter of "tropical chills". Visitors to the tropics have long warned of their perils and attributed subsequent indispositions to this phenomenon. An example occurs in the recent autobiography of an anthropologist:

> After walking home one day in the tropical midday heat, I had first mistakenly welcomed a cool breeze, sweeping through my thatched-roofed house; the result was a chill. (Powdermaker 1966, p. 98)

In India, this is one matter on which local opinion and English medicine have always been in hearty agreement.

> . . . Indian medical men . . . are fond of attributing almost every ailment to nocturnal chills . . . (Hill 1884, p. 339)

> The men should be advised and urged to wear flannel, and should never move, even in the hottest weather, without their blanket--a good stout brown blanket--for if subjected to sleep in the night air without tents and without blankets sickness must result. (Beatson 1857, p. 625)

---

[1] I am at a complete loss to reconcile these presumably long-standing and well-recognized regional variations in salt consumption with a just-published article, in which the author found that sedentary North Indian subjects (in Delhi, Ajmer, and Ratlam) consumed 12 to 15 g/day of salt, whereas South Indian subjects (in Madras and Waltair) ate only 8 g/day (S. L. Malhotra 1970, p. 1358). Malhotra apparently also recognized his findings to be anomalous, but was unable to explain them. India is indeed a land of contradictions!

Both this last-quoted Indian Army surgeon and Rudyard Kipling, Anglo-India's leading literary luminary, spoke of the deceptive quality of "tropical chills" in identical fashion:

> Indeed, it is difficult for those who have not felt it, to realise the intense feeling of chilliness produced by sleeping without some extra covering, in the night air, even at the hottest season of the year, in a tropical climate; and if we merely looked at the reading of the thermometer, it would be difficult to account for it. (Beatson 1857, p. 625)

> . ... the dawn would lower the thermometer from 96° to almost 84° for half an hour, and in that chill--you have no idea how cold is 84° on the grass until you pray for it . . . (Kipling 1898, p. 95)

It is recognized by physiologists expert in this field that the monotony and equability of a tropical climate produce a heightened acuity of perception of small temperature changes (Ellis 1953, p. 24). Beyond this, a prevalent medical explanation for the singular attention accorded to "tropical chills" has been well summarized by Stone:

> . . . the monotony of the weather is far more intrinsically disadvantageous to the maintenance of good health than its warmth or humidity. Where the variability in the sense of day-to-day changes is generally small, the body tends to lose its ability to adapt itself to any unusually marked change without some pathological or atonal consequences. This fact underlies the danger of "chills" in many tropical regions, which is strongly emphasized in all handbooks on tropical medicine and hygiene. . . . a small change which would pass unnoticed in a more variable climate may contribute to some definite malaise in the monotonous environment. (Stone 1941, p. 250)

Judging only from dry bulb temperatures, one would conclude that in North India it is in the hot sultry season--August and September--that the climate is the most unvarying (refer to Table 1). The average daily diurnal temperature range in Allahabad at this time is only 12 F.° (maximum 90° F. and minimum 78° F.), whereas in the hottest dry-season month of May it is 27 F.° (maximum 107° F. and minimum 80° F.). This apparent unrelieved monotony of heat stress might seem to provide one explanation of why it is precisely in August and September that North Indians feel themselves particularly vulnerable to chills, fevers, and simultaneous or rapidly succeeding heat and cold effects producing such sicknesses as the shītāng of folk belief.

However, a closer inspection makes the evidence seem much less conclusive on this point. For one thing, in August and September the insect and micro-organic carriers of infection are more active in North India than they are in the high burning heat of the dry season. Food scarcity also tends to be much more widespread in August than in May. For another thing, the standard available climatological records of dry bulb temperature (average, maximum, and minimum) are not the best indicators of actual thermal discomfort and stress. Of course, it is difficult to quantify duration and frequency in climatological data, and much more so to assign them accurate psychophysiological weighting, but this will become increasingly necessary if human bioclimatological effects are ever to be understood.

> A careful study of the frequencies of small weather variations in the tropics would be of more value than many of the averages usually available for climatic studies. (Stone 1941, p. 250)

An even more important consideration in judging medical-climatic relationships and effects is the fact that it is not the dry bulb temperature alone, but rather the combined effects of temperature, vapor pressure, wind, and radiation which determine the physiological impact of heat. These effects are approximated adequately only in a sentient temperature index such as Effective Temperature or its improved version, the Corrected Effective Temperature (see Appendix C). However, CET data are not given as a part of the climatological record of weather stations, and they can only be roughly estimated from that record. In the case of North India, it appears to me that estimated CET values in August and September show a much greater diurnal range than do dry bulb temperatures--in fact, may exceed those in May. More important, so far as the matter of the possible ill effects of exposure to fluctuations in the thermal environment is concerned, the sentient temperature in North India in August and September sometimes dips below a man's zone of thermal neutrality into the area of cold discomfort, something that seldom or never happens at the comparable daily minimum dry bulb temperatures of the April-June dry season, which are accompanied by much lower humidities.

Our examination of the thermal environment, of the human response and adaptation to it, and of its effect on health in North India, would be both incomplete and misleading without fully recognizing that all these occur within a distinctive culture and way of life. In a sense, the Indian villager walks on a different earth, under a different sun and sky, from those familiar to the temperate-zone Western man of the 1970's. All the striking physical manifestations of Nature--the wind, the rain, the sun, the heat and the cold, the surrounding plant and animal worlds--are still known and felt by most Indians in a closer proximity, a more direct and intimate way than is true in our technologically buffered civilization, where matters have reached the point that office buildings freeze one in summer and stifle him in winter. In India, there are very few people who can say with the American ambassador that

> . . . one goes from air-conditioned house in air-conditioned car to air-conditioned office. It is New England winter in reverse. (Galbraith 1969, p. 82)

The Indian way and tempo of life are more delicately adjusted to Nature's balance and rhythm. And in addition,

> The peasant lives in a world in which a personal God and a communing Nature are a constant invisible presence in his relation with his land and social environment. (Mukerjee 1940, p. 135)

Natural phenomena in India are always endowed with traditional meanings and emotional associations which link and interweave both with the complex societal fabric and, in relation to health and disease, with the individual regarded as a body-mind-soul system, a microcosm sensitively tuned to every change in the outside environment. As one result,

> Nothing so confounds a Westerner as the facility with which Indians find correspondences where the former sees only incongruities and inconsistencies. (Brass 1965, p. 34)

In surveying the whole gamut of Indian adaptations to climatic extremes, finally, it should be of interest to consider the remarkable claims of superhuman endurance and capacity associated with Yoga and other traditions of physical-psychic-spiritual discipline in India and Tibet. Especially relevant to the thermal physiologist is the famous lamaistic discipline of tummo, or voluntary hyperpyrexia. This has been well reported--in its external manifestations, at least--by many visitors to Tibet. An especially graphic description is that of Tucci (1967, pp. 84-89). Those yogins who have mastered the art of tummo, and attained the title repa or "cotton-clad", can endure without any apparent discomfort or harm the bitterest cold and the icy winds of Tibetan winter, clad only in a single thin cotton garment. Both psychological training and qualification and physical exercises are prerequisites to the mastery of tummo. These are questions which, so it might seem, physiologists could profitably investigate. But they are also an area of inquiry where many Hindu thinkers deny the adequacy and reliability of a scientific approach (or, rather, "the scientific method" as it is defined and accepted in Western tradition).

> To the Hindu specialist physiology divorced from psychology would be too crude to deserve the name of science. (Chaplin 1930, p. 16)

Western science is built on objectivist, positivist, and rationalist assumptions, which Hindu tradition generally rejects as fundamental sources of bias and error in the quest of human consciousness for both its proximate and its ultimate reality.

Indians tend to have a sturdy and abiding naturopathic point of view in health matters, which for better or worse is flattered and served by the ancient indigenous and heterodox medical systems of Ayurveda, Unani, and homeopathy. Western modern and "scientific" medicine has everywhere made spectacular advances in technology and in curative procedures, but its major weakness is in the non-technical areas of institutional organization, social delivery, and the shallowness and inadequacy of its philosophical grounding. This last, again from the quintessential Hindu point of view, results in too great a dependence on curing rather than preventing, on combatting objectified micro-organic villains rather than promoting the conditions of psychosomatic harmony, and, finally, in an incapacity to accept, relate to, and tap the profound inner potentials and essential spiritual nature of human being. Thus, it may not be out of place to end this document with a sincere expression of hope that the best of both medical worlds will finally be successfully blended in the India of the future.

LIST OF REFERENCES

Aggarwal, S. C. 1956. _The Salt Industry in India_. Delhi: Manager of Publications

Ashby, Lilian Luker. 1937. _My India_. Boston: Little, Brown and Co.

Basham, A. L. 1963. _The Wonder that Was India_. New York: Hawthorn Books

Bates, Marston. 1952. _Where Winter Never Comes_. New York: Charles Scribner's Sons

Beatson, G. S. 1857. "On coup de soleil, its causes and treatment", _The Medical Times and Gazette_, n.s. Vol. 15, pp. 624-626

Belding, Harwood S. 1962. "Hazards to health: work in hot weather", _The New England Journal of Medicine_, Vol. 266, pp. 1052-1054

Brass, Paul R. 1965. _Factional Politics in an Indian State_. Berkeley: University of California Press

Brown, Hilton. 1948. _The Sahibs_. London: William Hodge and Co.

Burridge, William. 1944. _Climate and Labour_. Allahabad: Kitabistan

Chaplin, Dorothea. 1930. _Some Aspects of Hindu Medical Treatment_. London: Luzac and Co.

Chatterjee, Sujan B. 1954. _Indian Climatology_. Calcutta: Commercial Printers

Chaudhuri, Nirad C. 1951. _The Autobiography of an Unknown Indian_. London: Macmillan and Co.

_____. 1965. _The Continent of Circe_. London: Chatto and Windus

Crooke, William. 1968. _The Popular Religion and Folk-Lore of Northern India_. New Delhi: Munshiram Manoharlal (2 vols.) (first published in 1893)

Das, Frieda Hauswirth (Mrs. Sarangadhar). 1930. _A Marriage to India_. New York: The Vanguard Press

Dill, David Bruce. 1938. _Life, Heat, and Altitude_. Cambridge: Harvard University Press

Edelstein, Ludwig. 1948. Preface, pp. i-lix in _Hindu Medicine_, by H. R. Zimmer. Baltimore: The Johns Hopkins Press

Ellis, F. P. 1953. "Tropical fatigue", pp. 21-39 in Tropical Fatigue (W. F. Floyd and A. T. Welford, eds.). London: H. K. Lewis and Co.

Fletcher, John. 1966. "Multiple stress-strain relationships in man", pp. 26-31 in Human Adaptability to Environments and Physical Fitness (M. S. Malhotra, ed.). Madras: Defence Institute of Physiology and Allied Sciences

Frykenberg, Robert E. 1968. India. Boston: Ginn and Co.

Galbraith John Kenneth. 1969. Ambassador's Journal. Boston: Houghton Mifflin

Givoni, B. 1962. "The influence of work and environmental conditions on the physiological responses and thermal equilibrium of man", Arid Zone Research, Vol. 24, pp. 199-204

Gourou, Pierre. 1953. The Tropical World. London: Longmans, Green

Hagen, Louis. 1946. Indian Route March. New York: Pilot Press

Heimann, Betty. 1964. Facets of Indian Thought. London: George Allen and Unwin

Hill, S. A. 1884. "The effects of the weather upon death rate and crime in India", Nature, Vol. 29, pp. 338-340

Kendrew, W. G. 1927. The Climates of the Continents. Oxford: The Clarendon Press

King, E. August (Mrs. Robert Moss King). 1884. The Diary of a Civilian's Wife in India, 1887-1882. London: R. Bentley and Son (2 vols.)

Kipling, Rudyard. 1898. "The man who would be king", pp. 84-142 in The Phantom Rickshaw and Other Stories. Philadelphia: Altemus

_____. 1919. Rudyard Kipling's Verse. Garden City, N. Y.: Doubleday, Page and Co.

Lee, Douglas H. K. 1944. Physiological Principles in Tropical Housing. University of Queensland. Department of Physiology

_____. 1958. "Proprioclimates of man and domestic animals", pp. 102-125 in Climatology. Reviews of Research. Paris: UNESCO

_____. 1963. Physiological Objectives in Hot Weather Housing. Washington, D. C.: Housing and Home Finance Agency

Lind, A. R. 1964. "Physiologic responses to heat", pp. 164-195 in Medical Climatology (Sidney Licht, ed.). Baltimore: Waverley Press

Lyon, Jean. 1954. Just Half a World Away. New York: Thomas Y. Crowell

Malhotra, M. S. 1964. "Salt requirements of acclimatized people during summer in the tropics", pp. 97-99 in Environmental Physiology and Psychology in Arid Conditions. Proceedings of the Lucknow Symposium Paris: UNESCO

_____. 1966. "People of India including primitive tribes--a survey on physiological adaptation, physical fitness, and nutrition", pp. 329-355 in The Biology of Human Adaptability (Paul Baker and J. S. Weiner, eds.). Oxford: Clarendon Press

Malhotra, S. L. 1970. "Dietary factors causing hypertension in India", American Journal of Clinical Nutrition, Vol. 23, pp. 1353-1363

Manson-Bahr, Sir Philip H. Manson's Tropical Diseases. London: Bailliere, Tindall and Cassell

Morris, Morris David. 1967. "Values as an obstacle to economic growth in South Asia: an historical survey", Journal of Economic History, Vol. 27, pp. 588-607

Mukerjee, Radhakamal. 1940. Man and His Habitation. London: Longmans, Green and Co.

O'Malley, L. S. S. 1917. Bengal, Bihar and Orissa Sikkim. Cambridge: University Press

Peel, Cyril. 1958. "Thermal conditions in traditional mud dwellings in northern Nigeria", The Journal of Tropical Medicine and Hygiene, Vol. 61, pp. 189-203

Powdermaker, Hortense. 1966. Stranger and Friend. New York: W. W. Norton and Co.

Renbourn, E. T. 1962. "Tropical clothing. A physiological appreciation", pp. 91-98 in Biometeorology (S. W. Tromp, ed.). Oxford: Pergamon Press

Sargent, Frederick II and Zaharko, Daniel S. 1962. "Medical-meteorological forecasting--an application of fundamental bioclimatological concepts", pp. 174-195 in Biometeorology (S. W. Tromp, ed.). Oxford: Pergamon Press

Schickele, Elizabeth. 1947. "Environment and fatal heat stroke", The Military Surgeon, Vol. 100, pp. 235-256

Sherring, M. A. 1872. Hindu Tribes and Castes, as Represented in Benares. London: Trubner and Co.

Smith, Bradford. 1962. Portrait of India. Philadelphia: J. B. Lippincott

Sohar, E. 1970. "Climate and society", pp. 99-104 in Biometeorology, Vol. 4, Part I (S. W. Tromp and W. H. Weihe, eds.). Amsterdam: Swets and Zeitlinger N. V.

Sohar, E. and Adar, R. 1964. "Sodium requirements in Israel under conditions of work in hot climate", pp. 55-62 in Environmental Physiology and Psychology in Arid Conditions. Proceedings of the Lucknow Symposium. Paris: UNESCO

Stone, Robert G. 1941. "Health in tropical climates", pp. 246-261 in Climate and Man. Washington, D. C.: Department of Agriculture

Thoburn, W. C. 1946. "The comfort problem in northern India", Heating, Piping and Air Conditioning, Vol. 18, pp. 120-125

Thornhill, Mark. 1899. Haunts and Hobbies of an Indian Official. London: J. Murray

Trevelyan, G. O. 1864. The Competition Wallah. London: Macmillan

Tromp, S. W. 1963. Medical Biometeorology. Amsterdam: Elsevier Publishing Co.

Trumbull, Robert. 1957. As I See India. London: Cassell and Co.

Tucci, Giuseppe. 1967. Tibet: Land of Snows. New York: Stein and Day

Whitehead, Henry. 1921. The Village Gods of South India. Calcutta: Association Press

Wulson, Frederick R. 1949. "Adaptations to climate among non-European peoples", pp. 3-69 in Physiology of Heat Regulation and the Science of Clothing (L. H. Newburgh, ed.). Philadelphia: W. B. Saunders Co.

Wyndham, C. H. 1962. "Research needs in tropical climatology", pp. 533-540 in Tropical Health. Washington, D. C.: National Research Council. National Academy of Sciences

_____. 1964. "Performance and comfort standards in relation to climate", pp. 189-198 in Environmental Physiology and Psychology in Arid Conditions. Proceedings of the Lucknow Symposium. Paris: UNESCO

APPENDIX A

DESCRIPTION OF AYURVEDIC MEDICINE

Like every indigenous Hindu art and science, Ayurvedic medicine has its roots not only in the Vedas (3000 - 1000 B. C.) of the Indo-Aryans but also in the unrecorded prehistory of the subcontinent's aborigines. This pre-medical lore and magic was shaped and systematized as Ayurveda, the "Wisdom of Long Life", during the intellectual ferment that marked the Buddhist period in India from 500 B. C. to the early centuries of the Christian era. Hindu traditions of course mythically derive Ayurveda from a divine source.[1]

Even the earliest, the most authoritative and best-known Ayurvedic compendium, the Caraka Samhita of Caraka (probably the court physician of the Indo-Scythian king Kanishka of Peshawar about 78 A. D.) is not an original work but a redaction of earlier written or unwritten sources (Riepe 1961, p. 180). At the same time, it reflects additions and revisions several centuries later by another Kashmir physician, Dridhabala (Hoernle 1907, p. 2). A second, almost equally lengthy and renowned compendium, the Sushruta Samhita, is attributed to the surgeon-physician Sushruta, who lived in the 4th century A. D., reputedly in ancient Kashi, the present-day Varanasi.[2] Completing the so-called "Triad of the Ancients" was Vagbhata (the Elder), whose early (600 A. D.?) Ashtanga Samgraha was the basis of another major compendium, the Ashtanga Hridaya Samhita or "Quintessence of Medicine", by Vagbhata (the Younger) in about the 8th century A. D.

---

[1]The nature and extent of reciprocal influences between early Greek and early Hindu medicine are important problems which concern Orientalists, but they are too unresolved and complex to detain us (see Filliozat 1964).

[2]According to Kutumbiah, whose explication of Ayurvedic medicine is perhaps the best yet available in English, Caraka was largely indebted to the Nyaya-Vaisesika school of philosophy, whereas Sushruta drew more from the Samkhya (Kutumbiah 1962, p. xxi). Certainly there are many points of difference between the two great works.

In the 12th century Madhavacarya, prime minister to King Vira Bukka of Vijayanagar, compiled his study of diagnosis and pathology, the Madhava Nidanam. Few original works of Ayurveda have been produced since this time, although the Bhavaprakash Nighantu of Bhavamisra (1550 A. D.) is a well-known encyclopedic study, the Bhaishajyarat-navali of Govind Das is a rich sourcebook, the Cikitsa Samgraha of Cakradatta is noteworthy, and there are numerous other minor and specialized contributions.[1] Very little of this literature has been translated into European languages, and Ayurvedic experts in India regard all existing English translations of the Caraka Samhita and the Sushruta Samhita as quite imperfect. Caraka remains the great authority in Ayurveda for therapeutics (cikitsā), Sushruta for anatomy (sharīra) and surgery (shālya), Vagbhata for principles of medicine (sūtra), and Madhavacarya for diagnosis (nidāna).[2]

Although India is politically a secular state, Hinduism and traditional Hindu society--which are still viable, and of which Ayurvedic medicine is an integral part--are in an important sense "sacred", and thoroughly permeated with religious beliefs and practices. Thus, the professionalism of Ayurveda was and is largely the prerogative of the Brahman caste. And in theory Ayurvedic treatment has always concerned itself as much with the patient's mind and soul as with maintaining and restoring the health of his body. As balance and harmony among the bodily humors is the physical goal of Ayurveda, so are detachment from the bondage of matter and the striving for spiritual enlightenment and moksha (liberation from the cycle of rebirths) the

---

[1] The Cikitsā-Sāhitya or "Medical Catalogue" of books printed and stocked by the Chowkhamba (Caukhambā) Press in Varanasi lists hundreds of Ayurvedic books and pamphlets, of which fewer than 30 (in the 1966 edition) were in English.

[2] These constitute four of the traditionally "eight-limbed" (ashtānga) study of medicine and healing in ancient India. Many more specialized subjects appear in the list of courses taught in the 6½-year Shuddha Ayurveda curriculum (Report of the Shuddha Ayurvedic Education Committee, 1963, p. 21), but as one apparently rather cynical observer notes: "The lists of subjects vary, and today run into dozens of headings, since newly-coined Sanskrit names are added to the catalogue as soon as fresh discoveries are made in the West" (Walker 1968, Vol. I, p. 104).

ideological motives which generally color and condition this indigenous medical system.

> . . . the value of medical care is measured by man's higher destination. The sound body is, and ought to be, made the instrument of spiritual experience through which one becomes conscious of the indestructibility of one's true self, of that part within man which is behind his individuation. (Edelstein, in Zimmer 1948, pp. xlii-xliii)

The basic categories or principles of the Ayurvedic system of therapeutics and pharmacy are common to those of Indian philosophy, although Orientalists have shown that some of the cardinal Ayurvedic terms in fact evolved from earlier and cruder usages (Brown 1921; Blair 1961). They involve, first of all, the recognition of a fundamental universal dualism of spirit and matter. Along with this goes the belief in macrocosmic-microcosmic correspondence, that a man is himself a replication of the cosmos. The material aspect of this universe is composed of the five bhūtas or fundamental elements of earth, water, fire, air and ether--or rather, of five physical principles which are exemplified in earth, water, fire, air and ether (Kashikar 1953, pp. 235ff). In the microcosm of the body, earth is represented in the bones, teeth, muscles, skin, etc.--all the parts of the body which show the universal qualities of "earthiness", being heavy, bulky, motionless, hard, and solid. Water is represented in the body by blood, fat, lymph, urine, etc.; fire by heat, digestion, anger and the like; air by respiration and movement in general; and ether by the pores and body channels. Each of the five bhūtas include a sense: smell is of earth, taste of water, vision and color of fire, touch of air, and hearing of ether.

Another general metaphysical division which permeates Indian thought is that of the three guṇas or triguṇas, the three "qualities": rajas, tamas and sattva. This is a categorical trinity of the kind that has been found throughout the history of human thought, Oriental and Western, up to the present date. Rajas is the quality of energy or that which causes activity, restlessness and passion. Tamas is that in nature which is heavy, dark, indifferent and inert. Sattva is that in nature which is pure, light-giving, true and good (Hill 1952, p. xxiii). Again, Rajas is the quality of will, Sattva of intellect, and Tamas of emotion. Sattva is knowledge, Rajas activity, Tamas ignorance. Sattva is white, Rajas red, and Tamas black. There are rājasik, tāmasik and sāttvik people, foods, etc.[1] Many more extensions and applications of this trinity of gunas or fundamental qualities have been elaborated in Hindu life and thought.

The concept of guna or "quality" has been further extended, especially in the context of dietetics and pharmacy in Ayurveda, in the enumeration of the ten contrasting pairs of dravyagunas. These twenty dravyagunas are the descriptors of fundamental metaphysical qualities which in thousands of different combinations and permutations characterize every material substance, and in medicine are particularly used to describe the properties and effects of foods and drugs, as well as the physical symptomatology of disorders. The dravyagunas are usually rendered as follows:

guru	(heavy)	laghu	(light)
shīta	(cold)	ushna	(hot)
snigdha	(viscous, oily)	rūksha	(dry)
manda	(torpid, dull)	tīkshna	(active, sharp)
sthira	(stable, firm)	sara	(unstable, fluid)
mridu	(soft)	kathina	(hard)
picchila	(sticky, slimy)	visada	(clear)
slakshna	(smooth)	khara	(rough)
sthūla	(bulky, gross)	sūkshma	(thin, fine)
sândra	(dense, solid)	drava	(liquid, fluid)

In some cases several English terms are needed to suggest all the connotations of the Sanskrit or Hindi terms.

[1] In a singularly chauvinistic, yet not untypical, modern apologia for Ayurveda and concomitant pejoration directed at Western civilization, the presidential address to the 1942 All India Ayurvedic Congress noted that only freshly-cooked food should be eaten, since foods more than 48 hours old become tâmasik, causing their consumers to be ill-tempered, malicious, avaricious, haughty and criminal. It was the speaker's conclusion that: "People in civilised countries of the West usually take in hotels the Tamasik food--a root cause of their warring tendencies" (Shastri n.d., p. 105).

Ayurvedic physiology as such begins with the principle that the five fundamental elements (bhūtas), as combined and modified in a living man, constitute seven dhātus (tissues or literally "upholders of the body"): chyle, blood, flesh, fat, bone, marrow, and semen. These seven "tissues" are created by the metabolism of food, the fuel for the digestive fire. This gastric or digestive fire is a central and important tenet in Ayurveda, which holds that a man's vitality, energy, good health and very life span are dependent upon the gastric fire, which needs to burn brightly and evenly. Digestion is likened to a process of cooking. The first product of the digestion of food is thought to be a colorless fluid--the chyle (including lymph, serum, etc.) or first "tissue". By further "cooking" it is transformed into blood by passing to the liver and taking on color. Then it is changed into flesh, and from flesh into fat, from fat into bone, from bone into marrow, and from marrow into semen, which is considered to be produced throughout the body. This whole process of distillation is supposed to take thirty days, five days to each stage.

Semen, when conserved in the body rather than expended through sexual activity, is believed to produce a substance of special value and spiritual force, ojas, sometimes called the eighth dhātu. Ojas returns to the heart as a kind of energy, and is thence diffused over the whole body (Basham 1963, p. 501).

> Ojas ist in der Medizin anerkannt als "lebenkraft", stets hochbewertet . . . (Müller 1959-1960, p. 221n)

There is a widespread folk belief in North India that it requires 40 drops of blood to form one drop of semen. Carstairs, in Rajasthan, found a belief that

> This semen, in which lies the source of a man's strength and of his subjective sense of well-being, is stored in a reservoir in his skull, which has a capacity of about 20 fluid ounces. (Carstairs 1955, p. 124)[1]

---

[1]This idea is related to the themes in Hindu religious life pertaining to sexual continence, the psychic powers of ascetics, etc., and in ordinary life with male genito-urinary dysfunctions (see p. 246). Various aspects and implications of the subject have been noted by a number of scholars, for example Carstairs (1955), Basham (1963), and Bharati (1970).

In addition to its division into seven <u>dhātus</u>, the body is also seen as being permeated by, or in a sense actually composed of, three "humors": <u>vāta</u>, <u>pitta</u> and <u>kapha</u>. In theory, or in that ideal perfection of health which in practice is virtually unattainable due to the constant disequilibrating effects of the physical and psychic environments, these three humors are regarded as veritable <u>dhātus</u>, "upholders of the body". A modern expositor of Ayurveda describes them as follows:

> . . . the Dhatu-Triad, Vata, Pitta and Kapha, represent in the living individual those universal and inseparable Thrigunas, Rajas, Satwa and Tamas, hypostatized, according to preponderance of one or other Guna, into Life, Mind and Matter, or the Vitality principle, the Psychic principle and the Physical Matter principle. (<u>Report of the Committee on Indigenous Systems of Medicine</u>, 1948, Vol. II, p. 327)

However, the three humors simultaneously have two further aspects. At each stage in the Ayurvedic model of metabolism, certain waste products or by-products are created which do not enter into the further successive stages of digestion. According to some descriptions of the Ayurvedic model, the humors actually have their source and origin here. At any rate, the humors are not of medical importance as <u>dhātus</u> or "upholders", but only as <u>dōshas</u> ("disorderers") and as <u>malas</u> ("excretory products"). In the latter aspect each of the three humors has its characteristic form of <u>mala</u>, both physical and immaterial. In its aspect as <u>dōsha</u>, each humor comes to be regarded as a force in or a component of the body, almost taking on a spontaneous will or personality, and thus tending to create imbalance. Since the three humors, each in theory a Dhatu-Dosha-Mala entity, seem in practice to concern men chiefly in their aspect of quasi-willful <u>dōshas</u>, it is as <u>dōshas</u> that they are commonly known, and in fact Ayurveda is often called "the Science of Tridosha".

Vata, Pitta and Kapha have been poorly rendered in English as "Wind", "Bile" and "Phlegm", although these terms are certainly not at all what Caraka, Sushruta and their followers meant. According to Caraka's description of the metabolistic ontogenesis of the <u>dōshas</u>, one of the first things that happens when food is digested is that a sweet reaction sets in, producing a foamy Kapha. Later a sour reaction takes place, causing a liquid form of Pitta to arise. When the food moves to the intestine where it is dried up and solidified by the digestive fire, a bitter and astringent reaction results, and due to this the humor Vata is generated.[1]

Some scholars say that the humoral concept may have developed historically out of the notion of the five bhūtas, since Vata resembles the element air, Pitta fire, and Kapha water. But they are more philosophically understood by the Brahman priest-physicians to be the three microcosmic representatives of the three divine forces Wind, Sun, and Moon, seen as cosmic and vital principles as well as physical or natural phenomena.

> The moon pours down renewal of the sap of life; the sun by its draining rays withdraws this sap from the creatures; the wind moves to and fro in various directions. Thus they support the body of the universe and in like fashion the antagonistic activity of phlegm, bile and wind support the microcosm. (Zimmer 1948, pp. 134-135)

Sophisticated Ayurvedic apologists today may claim that Vata, Pitta and Kapha are functionally comparable to kinetic energy, molecular energy, and humidity, or that they represent physiologically correlative, generative, and sustentative functions (Chaplin 1930, p. 11). According to Kaikini, Vata may be likened in function to the nervous system, a controlling and moving principle in the body, although it is totally invisible like air. Pitta corresponds to the digestive system, to which are added all functions involving cell metabolism, heat production, and the giving of color and vitality to the body. Kapha is often identified with the mass and the fluids of the system, but in his attempt to rationalize Ayurveda in Western physiological terms, Kaikini links it with the respiratory system (Kaikini 1965, p. 633). Bhattacharyya likens the three dōshas to three basic elements of nuclear physics:

---

[1]In accordance with this idea, Ayurveda prescribes that every meal should be arranged so that a definite sequence of foods containing proper "qualities" and "tastes" is followed to harmonize with the humoral ontogenesis. Many of the numerous (in theory, 60) combinations and permutations of effects of the 20 dravyagunas on the three dōshas are detailed by Müller (1959-1960, pp. 202-203)

neutron = Vata; electron = Pitta; and proton = Kapha (Bhattacharyya 1951, p. 2). At the same time, he far outdoes Zimmer in establishing mythological-symbolic correspondences, somewhat as follows: (1) Brahma - red - fire = Pitta, creator in the body as Brahma is Creator in the universe; (2) Vishnu - blue - air = Vata, like air the preserver of life as Vishnu is the Preserver-deity; and (3) Shiva - white - water = Kapha, the cold which destroys heat as Shiva is the Destroyer of the world (Ibid., pp. 2-3). Vaidyaratna Captain G. Srinivasa Murti, to whom 20th century Ayurveda in India owes so much, elaborated his own personal integration of all the Hindi five-fold and three-fold principles with Western scientific physics, physiology and psychology as he understood them, but it is impossible to do justice here to his ingenious and ambitious theoretical constructs.[1]

Each of the three humors is considered to be composed of five parts, or to have five branches. Vata, for example, includes Prana, the Vata which moves outward from the mouth and face; Udana, the Vata which moves upwards in the body and which is often responsible for head diseases; Samana, the concentrating Vata, centered in the stomach; Vyana, the Vata which distributes, which causes blood, sweat, etc. to be propelled all over the body; and Apana, the downward wind which effects excretion, childbirth, and the like. Pitta's five divisions (Pachaka, Ranjaka, Alochaka, Sadhaka, and Bhrajaka) are responsible for digestion, cell metabolism, imparting color to the blood, giving color to the eyes, body hormonal action, and body regulation and complexion. Kapha's five parts (Avalambaka, Kledaka, Bodhaka, Shleshaka, and Tarpaka) have to do with moistening and lubricating aspects of the respiratory tract, digestive tract, mouth, joints, etc.

The Ayurvedic theory is that all the three humors are diffused throughout the body. However, Kapha has its central focus in the chest area, Pitta in the stomach, and Vata in the lower abdomen. It is believed that these humors move throughout the body in 746 ducts or channels.[2]

---

[1]See his The Science and the Art of Indian Medicine (Adyar: 1948).

[2]This is according to Sushruta. Other vaidyas have held the number to be virtually countless (Zimmer 1948, p. 165), and the redoubtable Shastri proclaimed that "The science that has discovered $3\frac{1}{2}$ crores [35,000,000] of Shiras, Dhamnis and Rakta Vahinis in the body can never be incomplete or unscientific" (Shastri n.d., p. 53)

These are of three kinds, depending on their size--we might say capillary-like, vein-like, and the size of major arteries. Caraka and Sushruta did not identify them with the circulatory vessels, however; they were a sort of hypothetical postulate to explain how the hum..s could move around in the body.

The explanation for the incomplete and distorted Ayurvedic picture of human physiology may well be that the early medical specialists, being Brahmans, could not handle a corpse without suffering pollution. They sought to avoid this taboo by the ingenious method of having a cadaver wrapped in grass, placed in a wicker cage and hidden in a flowing stream. After about a week the body was removed and unwrapped, and the doctors and their students or disciples took brushes to brush gradually away the flesh and organs down to the bones in order to study the anatomy. Their method led to a reasonably accurate osteology,[1] although even this suffered from the fact that they had mostly immature specimens for dissection, since everyone over the age of five was cremated. The doctors' knowledge of musculature was fair, but their understanding of the dynamics of all the vital internal systems was minimal. The heart, the lungs, and the brain, for example, were only mentioned to be passed over and then practically ignored. The heart was considered to be a reservoir of the blood and certain other fluids, on the analogy of an irrigation system. Intellectual functions were also attributed to the heart. Caraka apparently thought the lungs' chief function was to produce moisture for the throat and mouth.

Ayurveda sees practically all kinds of sickness as problems of disharmony and derangement of the three humors. Even wounds and injuries take on aspects of involvement of the humors which need to be considered in the treatment. In fact, the balance of the <u>dōshas</u> is constantly being tilted or upset by many factors--by the external environment, the individual's food intake, his behavior, his psychological state, etc. The general principle here is that each humor is increased or provoked by whatever in nature is similar to it, and is decreased or subdued by whatever is dissimilar.

> Of all things, at all times, similarity is the cause of increase, and dissimilarity is the cause of decrease. (Kaviratna 1890-1901, p. 509n)

---

[1]The number of bones described in the human body was 360 (Hoernle 1907, p. 165).

The normal individual can tolerate a considerable amount of this kind of fluctuation--more so if he is young and healthy, and is himself of balanced humoral constitution.

For disease to develop, Ayurveda holds that it is necessary for three successive connections to be formed. First, there must be a <u>nidāna</u>, a predisposing cause. This is the first thing the <u>vaidya</u> or doctor looks for, and Nidana is a major branch of Ayurvedic medicine as taught in schools today. The predisposing cause generally falls, according to Caraka, into the categories of immoderation, immorality,[1] or exposure to harmful environment.[2] The second connection that must occur to produce disease is that one of the <u>dōshas</u> must be definitely provoked (increased) or vitiated (lessened); and third, it must then create a harmful effect on some one or more "tissues" of the body. When these three all occur in sequence there is frank disease. Otherwise, only mild illness or perhaps no apparent symptoms develop.

Actually, five distinct stages in the course of illness are recognized in Ayurvedic medicine, and the doctor's determination of the exact stage can be every bit as important in therapy as his diagnosis of cause and the humor involved. The five stages are <u>sancaya</u> (accumulation), <u>prakopa</u> (diffusion), <u>prasára</u> ("fermentation"), <u>vyakti</u> or <u>pūrva-rūpa</u> (early symptoms) and <u>rūpa</u> (full manifestation). It is only in the last stage that distinctive symptoms, such as Western medicine would recognize, of

---

[1] In the contemporary day-to-day practice of the Ayurveda-colored folk medicine of village North India, this aspect--the idea that "breach of taboo" can cause illness--is often singularly important. In a Rajasthan village, Carstairs found the principle to be mediated through the idea, previously referred to, of semen conservation and concluded that: "In general, it can be said that any violation of the many strict rules of behavior which concern the orthodox Hindu is regarded as detrimental to his store of semen, and thus to his mental and physical well-being" (Carstairs 1955, p. 125).

[2] The most important <u>ultimate</u> cause is the "unnatural" contact of the ten sense-organs (five organs of sense and five of action) with their respective sense-objects. Such unnatural contact may be of three kinds: <u>ayōga</u> or non-use; <u>atiyōga</u> or over-use; and <u>mithyayōga</u> or improper use (Bhattacharyya 19[illegible]1, p. 17).

a disease occur. Present-day *vaidyas* may admit that microbes in the external environment are a threat to health. However, they are convinced that no disease will occur if the body is in balance, and that at any rate the microbes are not primarily causal, and are usually not present until a late stage of the disease. The theory is central to Ayurveda that the *vaidya* can and should ascertain disharmony developing before it reaches a serious stage, and treat it when it can still be headed off by diet and medicines which will restore the balance.

> The concept of preventing rather than curing disease is strong in Indian culture. (Taylor 1956, p. 48)

Every trivial deviation in the body's functioning should be taken as a warning.

> The physician should not wait until full fledged disease is established with all its symptoms. He should not waste his time in finding a name for the disease. He should not allow the disease to progress from the earlier to the next stage, if it is at all possible. (Lakshmi Pathi n.d., p. 8)

In describing the morbid functioning of the humors, some *vaidyas* and laymen almost seem to endow them with malevolent personality. Generally it is Vata which is most feared--there are said to be 80 diseases of Vata, 40 of Pitta, and 20 of Kapha. The humor which is originally at fault can infect the others, as it were. If two then become involved, the condition is called *sansarg*; if all three are provoked it is *sannipāt*, and such tridiscordance is very serious.

It is not so simple as this, however. After all, there are only three *dōshas* but innumerable diseased conditions. In the first place, each *dōsha* has several characteristics or qualities, and the provocation or vitiation that occurs will usually involve only two or three among these attributes, not all of them. For example, Pitta by itself or abstractly considered has attributes of dryness, heat, keenness, lightness, slight oiliness, color, bitter and sour taste, and odor of raw meat. Indications of its functioning are burning, warmth, suppuration, sweat, impurities, gangrenous ulcerations, secretions and redness. Vata has other attributes as well as somatic indicators, such as thirst, body pain, hardness, tastelessness in the mouth, numbing and paralysis. With

Kapha there is a third set, including cold, whiteness, sweetness, lethargy and itching. It is necessary for the vaidya not only to discover which dōsha, but also which of its attributes, is aggravated or at fault. Secondly, Ayurveda recognizes that the dynamics of any disorder of health cannot be understood except by considering the dōsha in relationship to the affected tissue, which in this context is referred to as dushya. Dōsha and dushya are in a sense active and passive principles in the disease process, and it is important to know which one predominates in any given case. Where the dushya predominates the condition is frequently seen as a decrease or "wasting" (kshaya) of the tissue itself, e.g., rasakshaya, or "wasting of chyle". Thirdly, as often as not there is one dōsha primarily involved and another which is subsequently affected (condition of bidiscordance or sansarg). The vaidya must therefore consider what effect the treatment to counter the primary humor may have on the accessory humor and must treat them in relation to each other. Finally, any one of the five parts or branches of each humor may be involved independently of the others. They may even be affected in apparently contradictory ways, according to some experts. When all the combinations and permutations arising from the interplay of variables described in the preceding paragraphs are considered, it is obvious that the number of morbid conditions which can be differentiated according to Ayurveda is virtually endless.

Individuals endowed with a good constitutional balance of the humors are considered more resistant to disease. According to Ayurveda, however, almost everyone displays some innate tendency to relative excess or deficiency among the humors as a constitutional predisposition resulting from some combination of prenatal conditions, and is therefore more vulnerable to or easily upset by items of diet or aspects of climate and environment which manifest the qualities which would conflict with his dominant humor, or exacerbate his humoral deficiency. The individual can protect himself against his particular vulnerabilities so far as his choice of foods and his daily regimen are concerned, and it is important for the doctor to know the patient's humoral constitution because the effect of particular foods or medicine will vary accordingly.[1]

The changing seasons, and in fact timing and periodicity in all their aspects, are considered to be important by Ayurveda in leading to imbalance of humors.[2] Each of the three distinctive Indian seasons results in the increase of one of the humors. Thus, Kapha is naturally aggravated in the winter, and the excess of Kapha causes sickness when winter comes to a close. Pitta is naturally aggravated in the hot season (Ray 1937, p. 162). After that it is the turn of Vata, which is increased in the monsoon period. The pattern is repeated diurnally--there is an accession of Kapha in the morning, of Pitta at midday, and of Vata in the evening. As noted before, it appears in the stages of digestion also--Kapha arises while eating the meal,[3] Pitta in the post-prandial stage, and Vata a few hours later. Similarly in the life cycle, Kapha predominates in the first third of life, Pitta in middle age, and Vata in old age. The problem of coping with normal seasonal change is bad enough, but in addition there is

---

[1]The individual's constitutional type is known as prākriti. In one effort to validate scientifically the Ayurvedic concept of prākriti or constitutional type, a committee of vaidyas in the Ayurvedic Research Unit at Baroda Medical College undertook to classify all first-year medical students as to prākriti (they found 15 to be Kapha, 10 Vata, and 5 Pitta, in this instance). Subsequently, detailed laboratory studies were made of these students, but no consistent pattern of anatomical or physiological similarities could be found to correlate with the Ayurvedic prākritis that had been assigned. In fact, upon re-examination after two years, the vaidyas themselves were frequently not certain of the previously-designated prākritis! (Mehta 1962, p. 270). At present, research is being conducted at the Institute of Indian Medicine at Banaras Hindu University by Dr. H. C. Shukla on the correspondences between Ayurvedic constitutional types and the somatotypes developed by William H. Sheldon (see Shukla 1967). According to Dr. Shukla, the average or typical Kapha type is mesomorphic (about 3-5-2), the Vata type is ectomorphic (2-2-5), and the Pitta individual is endomorphic (5-2-2) (Shukla 1966).

[2]The Ashtanga Samgraha and the Ashtanga Hridaya Samhita are especially concerned with the seasonal aspects of illness.

[3]The fact that pān or betel is anti-Kapha in quality is cited as one reason it is customarily chewed at the end of meals.

the threat of unseasonable weather--an unusually warm day in winter or a chilly period in August, for example--and in everyday life this is always blamed for subsequent sickness.

In addition to constitution and seasonality, another factor to be considered in Ayurveda is country or habitat. Caraka distinguishes among Anupa (wet, marshy country), Jangal (dry plateau), and Sadharana, or mixed type. These are believed to have an effect on health also, but mainly an indirect one through the diet--that is, through eating plants or animals which are native to these habitats. The great Persian historian and physician, Abul Qasīm Farishta, is said to have noted in his compendium, Dastur-ul-Atibbā, that he was unable to obtain the same response to his medicines in India as he did in Persia, until he discovered the peculiarities of India in terms of its climate, soils and plants, and the particular temperament and constitution of the people which harmonized with these (Askari 1957, p. 13). This "medical particularism" is a principal argument in modern India in defense of the indigenous systems of medicine:

> He [the hakīm or vaidya] dissuades his patient from European medicines, because these are suited to a chilly climate and a hot constitution. (Crooke 1906, p. 323)

> The seers have studied the effects of herbs, etc. in reference to time and place--thus other systems of medicine are alien however excellent they may be in other climates. (Naidu 1918, p. 10)

Important as are climate and constitution, the single overriding factor in maintaining or upsetting the balance of the humors according to Ayurveda is diet. Food is considered the root cause of health or disease, and it follows that Ayurvedic dietetics and phytotherapy have been extensively elaborated.[1] One of the principal concepts in relation to food is that of the six rasas or digestive effects: sweet, sour, salty, bitter, pungent, and astringent (with 63 combinations and permutations). Every food and every medicinal preparation can be classified according to

---

[1]A primary source for Ayurvedic dietetics is the relatively recent Bhavaprakash Nighanti (codified by Bhavmishra in the 16th-17th century), which contains descriptions of all the food plants and their Ayurvedic qualities.

its rasa. Rasa is the initial taste characteristic, but at the same time it is much more than this--it is a digestive effect. Each rasa produces its own distinctive reaction in the body, partly because each is associated with different combinations of the five bhūtas or fundamental elements, of the dravyagunas, and so forth. Thus, the sweet rasa appeases thirst and hunger, the bitter rasa reduces the heat of the body, the astringent rasa augments the actions of any of the others, etc. (Walker 1968, Vol. II, p. 57). The quality of rasa can be superseded by that of vipāka, however. After it is digested or assimilated, food or medicine often develops a quality different from its rasa, and this is its vipāka. The number of vipākas is only three: sweet, sour, and pungent. Vipāka in turn is subordinate to the effect of virya. The virya is one of two kinds, "hot" or "cold", that is, having properties which either heat or cool the body. (The "hot" and "cold" concepts have become fairly dominant as folk dietetic principles in everyday village life, as compared to their lesser role in the classic Ayurvedic system.) Finally, a food or drug has its own prabhāva or specific action, and this quality takes precedence over the others. Two fruits, for example, may both be sour in rasa, sour in vipāka, and cold in virya, but only one might have a specific action of being a purgative. These concepts form the basis of Ayurvedic medical pharmacology, when combined with the other elements and qualities previously described. All the tastes or rasas should be represented in a balanced diet, and excess or deficiency of any taste--or even their wrong sequence during meals--can be a cause of humoral disorder. Some Ayurvedic interpreters have linked the six rasas with the six ritus or seasons in nature, one rasa being predominantly developed in each season. These associations are: Shishira (bitter); Vasanta (astringent); Grishma (pungent); Varsha (sour); Sharad (salty); and Hemanta (sweet).[1] Hence, it is said, in the cold season nature provides sweet foods their inherent sweetness; chillies grow best in summer; etc. (Lakshmi Pathi n.d., p. 62).

The quality of "heavy" and "light" in foods is very important both in traditional Hindu dietetics and in folk belief today. Foods called "light" contain largely the properties of air and fire, while those called "heavy" are primarily endowed with the properties of earth and water. In terms of rasa, sweet and sour are the "heaviest", while bitter is the "lightest". As examples, pork, green lentils, and raw

---

[1]See calendrical equivalents on p. 20 above.

rice are considered "heavy", while venison, black lentils and boiled rice are considered "light" (The Charaka Samhita, Vol. V, p. 27; Kaviratna 1890-1901, p. 454n). Foodstuffs can often be changed from "heavy" to "light" by processing them--by cooking, by ageing, by drying, by storing in vessels of certain substances such as brass or pottery, etc. One is advised to eat "light" foods exclusively in illness, and in health he can eat them to complete satiation without any worry, whereas he should eat only half this quantity of "heavy" foods at one time. It is believed that the "light" foods enhance the digestive fire, while the "heavy" foods tend to dampen it.

The Ayurvedic system admits endless possibilities of incompatibility of foods with each other, with the individual, with the season, etc. Certain combinations are regarded as actually toxic, such as honey and ghee, or honey combined in any way with wheat. Caraka and the other classic authors also abhor undigested food as a potential poison. There are strict warnings against eating anything until the previous meal has been digested. The mixing of food with semi-digested remains of a previous meal is believed to provoke immediately all the humors.[1] Another practice which is considered especially harmful, leading principally to Vata disorders, is the suppressing of any of the normal body functions such as eating, sleeping, vomiting, belching, coughing, excretion, or the sexual urge. It is repeatedly stressed in the Caraka Samhita that these impulses should not be unnaturally suppressed.

In addition to food intake or other behavior that is immoderate, incompatible or non-homologous, especially in relation to season and constitution, other sources of illness recognized by Ayurveda are traumatic injuries, breaches of the moral code (taken to be the cause of leprosy), the action of malevolent supernaturals, and witchcraft (especially in infants). Mental derangements are generally attributed to the last two causes.

---

[1]Whether it is winter or summer, North Indians traditionally bathe only before a meal (usually, before the noon meal), and not after it. As Walker says, "It is considered harmful to have a bath after a meal because the internal fires are being fed by the fuel of the food and cold water on the body quenches the fires, causing indigestion and various other diseases" (Walker 1968, Vol. I, p. 282).

Ayurvedic therapeutics necessarily lay very great stress on proper diagnosis. Not only does the disorder have to be identified, but also its stage must be determined, since a specific medicine for one stage may be useless and even harmful for a different stage of the same condition. The textbooks of Ayurveda repeat again and again that the physician must have very acute powers of observation; he must have empathy, must be sensitive to all kinds of signs and symptoms displayed by the patient and his surroundings. These abilities obviously cannot be learned from a book--the students or disciples are urged to continue sharpening their perceptions, to look for what is unique in each case. Caraka says, in a statement which has a rather modern ring to it: "The learned physician who is unable to win his way into the heart by the light of his scientific understanding is not entitled to treat disease".

Eight methods of diagnosis are enumerated in the Ayurvedic classics. One is feeling the pulse, a method not fully elaborated until relatively recently, influenced by Greek and Arabic sources. It has developed considerable intricacy in present-day Ayurveda, using three fingers touching in three places at the wrist, one finger for each of the humors, and on the right wrist for men, the left for women. The <u>vaidya</u> interprets on the basis of rate, rhythm, force, and other qualities, of the pulse. Bhattacharyya enumerates upwards of 60 different adjectives to describe the pulse as it is affected by the <u>dōshas</u>. For example, involvement of Pitta is indicated if the pulse is "hot", "jumpy", or "rapid"; Vata if it is "inflated", "shriveled", or "lightning"; Kapha if it is "cold", "weak", "heavy", or "waddling"; Vata and Pitta combined if it is "imperceptible", "circular", or "ropy"; Vata and Kapha together if it is "porous", "hollow", or "crooked"; Pitta and Kapha in tandem if it is "forceful"; and all three <u>dōshas</u> at once if it is "non-compressible", "tremulous", or "pin-point" (Bhattacharyya 1951, p. 43).

The seven other diagnostic methods as described by Caraka and Sushruta are inspection of the patient's body, especially the eyes, tongue, urine and excreta, and the sounds of his body (his voice, breathing, cracking of joints, etc.). The physician is supposed to make use of all his senses, especially the tactile sense by palpation and touch, but also visual, auditory, olfactory and taste. (In the last case, however, he is advised to do it only indirectly--for example, by interrogating the patient as to the taste in his mouth, or by seeing if a sample of his blood is eaten by a dog or a crow, or by noting the extent to which flies accumulate on his body, or by the behavior of body lice.) Great importance is attributed to the patient's dreams, with certain dreams indicating a fatal prognosis. The doctor also is alert to the occurrence of auspicious or inauspicious omens on his trip to visit the sick person.[1]

Caraka and Sushruta often reveal a sophisticated awareness of the doctor's problem in maintaining his public image. In many passages they warn him to determine first of all if the case is curable and, if it is not, to withdraw diplomatically in favor of the family priest. At the same time, the doctor is advised to refrain from revealing a fatal prognosis so as not to shock the family. And if he is asked by someone, he should sidestep the question by mentioning some favorable omen he has noted or by commenting on the good care which the patient is receiving, or some such thing. In general, the doctor should avoid treating diseases from which a patient has been suffering for more than a year (Zimmer 1948, p. 93). But in other passages, Ayurvedic literature notes that even incurable cases can be palliated, and urges that the doctor should at least try to do this much.

Of course, in actual practice an Ayurvedic, especially a "folk Ayurvedic", diagnosis is likely to be considerably more crude and stereotyped than the complex ideals just described. When there is pain and noise in the stomach, villagers blame Vata, which is regarded as a sort of gas in the body which may move from place to place and cause pains and swelling (Carstairs 1961, p. 82). Pitta is implicated with symptoms of burning sensations, giddiness, diarrhea and fever, while hard breathing, thirst, sleepiness, and lack of appetite are attributed to a disorder of Kapha (Sharpe 1937, p. 73). Similarly, in

---

[1]Neither the vaidya of yesteryear or of today would have any sympathy for the modern American M. D.'s unwillingness to make house calls. In any typical North Indian village area there are likely to be at least one or two vaidyas, as well as a number of faith-healers who treat the victims of dog-bite, snake-bite, and other ailments through the efficacy of holy mantras and medicines, and the power of the deity whom they worship. While some cynical villagers may hold that these unlicensed and often unlettered specialists are well enough repaid by those patrons who may happen to benefit from their ministrations, no one denies that there is one obligation which they all solemnly respect. That is, at any time of day or night, and in any weather, their vow compels them to hasten immediately to the house of any patient who urgently requests their help.

Bhojpuri-speaking eastern U. P. the standard village treatments always prescribe dry ginger for problems of bāī (Vata), coriander seed for pitt (Pitta), and fresh or green ginger for kaf (Kapha) (Opler 1963, p. 34).

Treatment in Ayurveda falls into two broad categories. Where the dōshas have collected, become excited and begun to spread, the type of treatment called samshāman or "putting down" is appropriate, the idea being to calm down the humors and bring them back to harmony without at the same time promoting their excretion. When this is insufficient, and especially at a later stage, samshodhana or "clearing up" treatment is required in order to rid the system of the accumulated and harmful humors. The milder forms of treatment often consist simply of dietary regulation, the idea being that if the digestive fire is increased the dōsha may be dried up on the analogy of a shallow pool drying up by wind and sun.

In fact, dietary prescription is an integral part of practically all Ayurvedic therapy, and any distinction between foods and drugs as curatives (or as preventives) is hard to maintain. The Chinese Buddhist visitor Huien Tsang noted some 1300 years ago that a seven-day fast was the commonest treatment for sicknesses, and that doctors were called in only if there was no improvement after that time (Saletore 1943, p. 163). Fasting still remains the favorite Ayurvedic treatment. "Light" (halkā) foods are given exclusively during convalescence, and upon breaking the fast. In the Madhopur village area of eastern U. P., for example, the favorite such convalescent foods are a combination of pulses of boiled mũg (Phaseolus aureus or "green gram") with gũrhī kī roṭī.[1] Incidentally, as so often happens in India, the very latest laboratory investigation has provided a scientific basis to folk practice. I refer here to a recent study of the comparative carbohydrate digestibility of some of the principal Indian pulses, carried out by P. Srinivasa Rao. "Digestibility" was defined as amount of maltose released per 100 mg. of cooked pulses, and by this criterion green gram or mũg ranked far ahead of the other

[1]First a version of gũrhī is made: barley is soaked, husked by pounding and cleaning, and "cracked" or broken into pieces. This is then mixed into balls with water and boiled. After boiling, it is rolled into a roṭī or "bread" form and dry-cooked much like a capātī.

legumes tested: arhar or red gram (Cajanus cajan), urad or black gram (Phaseolus mungo), and canā or Bengal gram (Cicer arietinum) (Rao 1969, p. 2155).

A tremendous variety of drugs were and are used in Ayurvedic therapy, and some of them (e.g., reserpine) have been shown to possess high specific value in modern times. There is an old saying found in the Caraka Samhita and widely quoted in India to this day to the effect that "everything that exists in the world has some medicinal use". However, in the proper preparation of Ayurvedic medicines careful attention must be paid to a number of things. For example, not alone is the specific plant important, but also the part of it that is used, whether root, stem, fruit, leaf, or flower.[1] Other considerations are the stage of maturity of the plant, the hour of day or night when it is plucked, and the category of soil in which it is grown (Heimann 1964, p. 39). In addition, the method and medium of preparation are critical. Some 23 forms of preparation are named, involving distinct processes (Nadkarni 1954, Vol. II, pp. 487ff.). For example, five principal modes of pharmaceutical preparation, ranging from most to least concentrated and potent in effect, are: (1) the expressed juice; (2) a paste; (3) a decoction; (4) a cold infusion; and (5) a hot infusion.[2] Again, the effect of the drug is believed to be quite different depending upon the anupāna or medium of administration--water, milk, honey, ghee, wine, or whatever. Some types of wine, incidentally, are highly recommended in the old tests, where 84 varieties of wine or intoxicating drinks are described, the most commonly mentioned being made from honey.

Also, various metals were and are used medicinally, especially in the form of oxides, sulphides, and chlorides. Mercury is known in Ayurveda as the "king of minerals", and arsenic and iron are also used internally. Gold in calcinal form is an ancient remedy for TB and joint diseases. Gold, silver, copper, and black iron, for example, are included in one of the favorite elixir recipes.

---

[1]These plant parts are listed in increasing order of their "lightness" or easiness of digestion, in current folk belief (Behura 1962, p. 130).

[2]Many other variations are possible. See, for example, the myriad uses made of mango, described on p. 155 above.

Makaradhvaj is one of the best-known Ayurvedic substances, a combination of mercury and sulphur which is simply a catalytic agent designed to potentiate other drugs (Sen 1916, p. 12). It is chemically identical with red sulphide of mercury, and Western pharmacopeias consider it devoid of therapeutic activity. But Chopra has described experimental tests on animal and human subjects which suggest that the compound, *if* prepared in the exact proportions and by the methods laid down, is in fact absorbed by the body in minute quantities and may produce a stimulant action on the heart, an increase in the number of red blood corpuscles, and an improvement in general nutrition (Chopra 1933, p. 421). The proper preparation of *makaradhvaj* requires 8 parts of mercury and one part of gold leaf amalgam, to which 16 parts of sublimed sulphur is added. All are powdered thoroughly for 24 hours in a stone mortar. The fine powder is gradually heated in a narrow-mouthed bottle on a sand bath, and after being kept at the proper temperature and then cooled, the *makaradhvaj* is found deposited on the inner surface of the bottle. Chopra notes:

> "Makaradhvaj" when taken regularly is believed in the indigenous system of medicine to be a wonderful tonic and is said to increase the longevity of the patient. (*Ibid.*, p. 416)

The "clearing up" or *samshodhana* treatments in Ayurveda consist largely of enemas, emetics, purgatives, errhines (nasal smoke and vapors), sudation, oleation, leeching, and cauterization. Having essentially a religious basis, Ayurvedic treatment also tends to include various ritual aspects. There is the idea of two mental *dōshas* in addition to the three physical humors, and most cases of what we would describe as mental illness were referred by the *vaidyas* to practitioners specializing in exorcism or propitiation.

As to the use of enemas, they were classified into five kinds (as the reader may have surmised, five is the favorite Hindu sacred number); these included plain, oily, alkaline, nutrient, and medicated enemas. Enemas are the treatment of preference in Vata diseases, and their importance in Ayurvedic therapy is indicated by Caraka's statement that "they are half the treatment if not the whole treatment as some physicians think". In Vata conditions one oily, warm enema mixed with meat juice is given; in Pitta conditions two enemas which are sweet and cold and mixed with milk are administered; and in Kapha conditions the rule is three enemas that are pungent, hot and acute, and mixed with cow's urine.

Smoking was therapeutically practised and highly recommended in the time of Caraka, who said: "A wise man should practise habitual smoking twice a day". Tobacco of course was not known, but various fragrant plants were either rolled into a cigar or smoked in a clay pipe. Three kinds of smoking were recognized: (1) sedative; (2) unctuous (here animal fat, ghee, or wax were included); and (3) medicated smoke for disorders of the head, especially to reduce Vata and Kapha.

In emetic therapy, to induce vomiting, a mixture of emetic nut with honey, licorice, rock-salt and treacle was given, followed by several days of rehabilitating diet, starting with nothing but thin rice water and gradually working through gruel, plain rice and juice of game-birds back to the normal diet. Emetics were the preferred treatment for Kapha diseases and for gastrogenic conditions. Purgatives were especially recommended for diseases of Pitta. Over 600 purgative preparations are described, falling into a number of categories for particular situations. The purgation therapy was preceded by sudation and oleation methods. Sudation covered the application of either moist or dry heat in order to produce perspiration, and 13 methods are described. There were 64 varieties of oleation--internal and external oiling procedures intended to increase viscosity, fluidity, softness and moistness in the body. Other kinds of treatment were impletion therapy, where the patient had suffered from too much luxury and indulgence; depletion therapy, where he was emaciated and debilitated; roborant therapy, to make one strong and robust; lightening therapy, to make the body lighter; desiccant therapy; and astringent therapy. Elixirs and virilifics of various kinds were particularly numerous.

Blood-letting and leeching were practised, especially in cases of "vitiated" or "bad" blood. The blood is deranged when Pitta is deranged, and also often by frequent use of oily, liquid and indigestible food, by anger, fire, exposure to sun, injury, etc. Bleeding could be done by incision or venesection where the individual was strong and robust, and by leeches on infants, old people, and those too delicate to be operated on. Leeches were recommended when Pitta was provoked, since they are water animals and have "sweet" properties, antagonistic to Pitta; in Vata conditions a cupping procedure using the horn of a cow was prescribed; and in Kapha conditions a hollow gourd, having pungent and parching properties opposite to Kapha, would be used.

Caustic applications were generally considered superior to surgery, the best of all being branding or cauterization, which is specifically recommended in cases of tumors, bad wounds, ulcers, headache, or elephantiasis, for example. Four grades of severity of burning were recognized, and again one of four shapes or brands would be suited to the case. Choice would also be made from among various substances to inflict the cautery: these included red-hot iron, copper, silver, a cow's tooth, a clove, boiling honey or oil, etc. An 800-year old Ayurvedic text described by Sharpe called for branding in specific places for the cure of certain diseases--for example, on the palate for a condition of enlarged testicles.[1] Special shapes of brand, such as a cross or a circle, were also prescribed. Miss Sharpe herself reported seeing a successful cure of a child with "wasting disease", given up by allopathic doctors, through branding by a red-hot clove held in a pair of pincers (Sharpe 1937, p. 56).

Hinduism has often been described as an immense conglomeration of themes and concepts which for the most part dovetail and interconnect to make coherent patterns, but which also--perhaps by sheer necessity of their very number and diversity--always include self-contradictions. This is also true in Ayurveda. For example, in Ayurvedic doctrine, no matter what kind of food or medicine is specifically recommended (in terms of "taste", "quality", and the like), the anūpāna must be of contradictory or opposite type. Anūpāna is the term used both for the liquid medium or vehicle of a drug and for whatever liquid drink a person uses at the end of his meal of solid food. The food or medicine is designed to combat the disorder; yet, its favorable action requires the provision of an ingredient which if taken alone would aggravate the illness! Indeed, one of the last sections of the Caraka Samhita even elucidates the proposition that there are a few rare situations where the physician must adopt procedures that would normally be contra-indicated, e.g., the reduction of certain excesses of Pitta by hot applications and of Kapha by cold. Here "heat subdues heat" and "cold destroys cold", a notion that is frequently encountered in village India today.

---

[1]According to Ayurveda, the "vessels" (or "nerves", as our closest English-language expression would have it) which control or especially influence some vital part of the body may be anatomically far removed from that part. Thus, the sole of the foot contains the "vessels" which govern eyes and eyesight. The application of cold, or walking barefoot in dewy grass, are believed to help the eyesight.

LIST OF REFERENCES

Ashtānga Hridaya Samhitā

Ashtānga Samgraha

Askari, S. H. 1957. "Medicines and hospitals in Muslim India", *Journal of the Bihar Research Society*, Vol. 43, pp. 7-21

Basham, A. L. 1963. *The Wonder that Was India*. New York: Hawthorn Books

Behura, N. K. 1962. "Meals and food habits in rural India", *Bulletin of the Anthropological Survey of India*, Vol. 11, pp. 111-138

Bhaishajyaratnāvalī (of Shri Govind Das). 1951. Banaras: Caukhamba Press (in Hindi)

Bharati, Agehananda. 1970. "The Hindu renaissance and its apologetic patterns", *The Journal of Asian Studies*, Vol. 29, pp. 267-288

Bhattacharyya, Benoytosh. 1951. *The Science of Tridosha*. New York: Gotham Book Mart

Bhāvaprakāsh Nighantu (of Bhavmishra)

Blair, Chauncey J. 1961. *Heat in the Rig Veda and Atharva Veda*. New Haven: American Oriental Society

Brown, George W. 1921. *The Human Body in the Upanishads*. Jubbulpore: The Christian Mission Press

The Charaka Samhita. 1949. Jamnagar: Shree Gulabkunverba Ayurvedic Society (6 vols.)

Carstairs, G. Morris. 1955. "Medicine and faith in rural Rajasthan", pp. 107-134 in *Health, Culture, and Community* (Benjamin D. Paul, ed.). New York: Russell Sage Foundation

______. 1961. *The Twice-Born*. London: The Hogarth Press

Chaplin, Dorothea. 1930. *Some Aspects of Hindu Medical Treatment*. London: Luzac and Co.

Chopra, R. N. 1933. *Indigenous Drugs of India*. Calcutta: The Art Press

Cikitsā-Sāhitya (Medical Catalogue No. 43). 1966. Varanasi: Chowkhamba Press

Cikitsā Samgraha (of Cakra Datta)

Crooke, William. 1906. Things Indian. New York: C. Scribner's Sons

Edelstein, Ludwig. 1948. Preface, pp. i-lix in Hindu Medicine, by H. R. Zimmer. Baltimore: The Johns Hopkins Press

Filliozat, Jean. 1964. The Classical Doctrine of Indian Medicine. Delhi: Munshiram Manoharlal

Heimann, Betty. 1964. Facets of Indian Thought. London: George Allen and Unwin

Hill, W. Douglas P. 1952. The Holy Lake of the Acts of Rama. London: Oxford University Press

Hoernle, A. F. Rudolf. 1907. Studies in the Medicine of Ancient India, Part I. Osteology or the Bones of the Human Body. Oxford: The Clarendon Press

India. Ministry of Health. 1948. Report of the Committee on Indigenous Systems of Medicine. Delhi (2 vols.)

_____. 1963. Report of the Shuddha Ayurvedic Education Committee. Delhi

Kaikini, V. M. 1965. "Romance of ancient Hindu medicine", Indian Journal of Medical Science, Vol. 19, pp. 631-641

Kashikar, C. G. 1953. Āyurvedīya-Padārthavijñāna. Bombay: The Board of Research in Ayurveda

Kaviratna, Avinash Chandra (ed.). 1890-1901. The Charaka Samhita. Calcutta: the editor

Kutumbiah, P. 1962. Ancient Indian Medicine. Bombay: Orient Longmans

Lakshmi Pathi, A. n.d. A Text-Book of Ayurveda (Ayurveda Siksha). Bezwada: the author

Mādhava Nidānam. 1958. Varanasi: Chowkhamba Press (in Hindi)

Müller, Reinhold F. G. 1959-1960. "Über indische Vorstellung von der Verdauung", Akademie der Wissenschaften. Institut für Orientforschung. Mitteilungen, Vol. 7, pp. 198-223

Murti, G. Srinivasa. 1948. The Science and the Art of Indian Medicine. Adyar, Madras: The Theosophical Publishing House

Nadkarni, K. N. 1954. Indian Materia Medica. Bombay: Popular Book Depot

Naidu, T. R. Ethirajulu. 1918. The Ayurvedic System. Madras

Opler, M. E. 1963. "The cultural definition of illness in village India", Human Organization, Vol. 22, pp. 32-35

Rao, P. Srinivasa. 1969. "Studies on the digestibility of carbohydrates in pulses", Indian Journal of Medical Research, Vol. 57 pp. 2151-2157

Ray, Dhirendra Nath (Dhīrendra-Nātha Rāya). 1937. The Principle of Tridoṣa in Āyurveda. Calcutta: S. C. Bannerjee

Riepe, Dale. 1961. The Naturalistic Tradition in Indian Thought. Seattle: University of Washington Press

Saletore, Rajaram N. 1943. Life in the Gupta Age. Bombay: The Popular Book Depot

Sen, Kaviraj Gananath (Gaṇanātha Sena). 1916. Hindu Medicine. Madras

Sharpe, Elizabeth. 1937. An Eight-Hundred Year Old Book of Indian Medicine and Formulas. London: Luzac and Co.

Shastri, J. K. n.d. (1943?) Presidential Address, 31st All India Ayurvedic Congress, Lahore 1942. Gondal

Shukla, H. C. 1966. Personal communication

______. 1967. "Caraka on inherited varieties of human constitution and their psychosomatic characteristics: a pre-Christian view", Prajna, Vol. 13, pp. 192-196

Taylor, Carl E. 1956. "Country doctor in India", The Atlantic Monthly, Vol. 197, No. 6, pp. 44-48

Walker, George Benjamin. 1968. The Hindu World. London: George Allen and Unwin (2 vols.)

Zimmer, Heinrich Robert. 1948. Hindu Medicine. Baltimore: The Johns Hopkins Press

APPENDIX B

CURRENT MEDICAL CLASSIFICATION OF HEAT DISORDERS

Modern medical classifications of the heat disorders are built upon a long history of uncertain diagnosis and treatment, which have been most entertainingly chronicled by Wakefield and Hall (1927) and Minard and Copman (1963), among others. As early as 1859 Levick realized that

> There has probably been much confusion prior to the 19th Century between sunstroke and cerebral apoplexy. (Levick 1859, p. 47)

Bloodletting was a favorite method of treating heatstroke in the past and, as Wakefield and Hall could add in 1927, ". . . even now in selected cases" (Wakefield and Hall 1927, p. 94).[1] Opiates were another leading treatment for heatstroke up to the 19th century. Cold packs or applications were widely used from an early date, but were usually combined with some "stimulant", such as mustard baths to the feet, turpentine injections, etc. By the time of the great New York City heatstroke epidemic of August 4 - 14, 1896, much the same kind of cooling treatment as would be given today had been established (Lambert 1897).

During World War II the urgent requirements of military medicine impelled considerable research toward a definition of the critical conditions predisposing to heat injuries as well as the description and interpretation of prophylaxis, pathology, therapy and--along with these--classification. Since 1945 probably more work has been done along these lines than in all of previous medical history. Nevertheless, it is not unusual to find much ambiguity and confusion in the area of heat disorders:

> An immense amount of experimental work on the effects of heat upon human physiology has been carried out during the second World War and so many papers have appeared on this subject, and as many views have been expressed, that it has become very difficult to present a reasoned statement. (Manson-Bahr 1965, p. 342)

---

[1]I must defer to experienced medical opinion as to what these "selected cases" were (or, possibly, are--although it is likely that phlebotomy has decreased considerably as a therapeutic procedure in the past 45 years). Probably, they consisted of the relatively infrequent heatstroke cases in which blood pressure was elevated, or some aberrant condition such as polycythemia was diagnosed.

Ladell, Waterlow and Hudson (1944), Shepherd (1945), and others have derived typologies of heat disorders based on etiology and symptomatology. Each skilled observer's classification has coherence and consistency in itself, based upon careful study of a particular population at a given time and place. However, when the various typologies are compared there appear to be almost as many contradictions as similarities. In his recent monumental study, Leithead has attempted to resolve these conflicts and has provided us probably the best available statement on the classification of heat disorders (Leithead 1964). Nevertheless, it is possible that differences due to intercurrent nutritional, medical and psychological states and perhaps to such factors as genetic makeup, state of acclimatization, and even cultural background have yet to be fully accounted for. At any rate, Leithead's categories of heat illness are essentially identical with those recognized by the World Health Organization, and are as follows:[1]

Heatstroke
Heat hyperpyrexia
— Following anhidrosis, febrile illness, or unqualified

Heat cramps

Heat exhaustion:

1. Anhidrotic
2. Salt-deficiency (excluding heat cramps)
3. Unqualified (including water-deficiency heat exhaustion, exercise-induced heat exhaustion, and heat syncope)

Sunburn

Prickly heat

Anhidrosis

Heat neurotic reactions (including chronic heat neurotic reaction, chronic heat fatigue, mild asthenic reaction, mild heat fatigue)

Other heat effects (including head oedema)

---

[1] Leithead 1964, p. 130

A. Minor Heat Disorders

1. Prickly heat

Heat rash, miliaria rubra, or prickly heat is a very common tropical affliction. Yet, according to Leithead,

> . . . there is much about the aetiology which remains uncertain and perhaps unknown [and] . . . the treatment of prickly heat is still highly unsatisfactory. (Leithead 1964, pp. 178, 185)[1]

The most effective treatment, when all is said and done, is simply exposure to an environment just cool enough to stop sweating, even for a few hours a day (Yaglou and Minard 1957, p. 314). The proximate cause of prickly heat is blockage of the sweat ducts, a condition resulting from prolonged wetting of the skin by sweat. However, there is a considerable difference of opinion with respect to the relative roles of acclimatization, length of residence in heat, daily duration of sweating, infection, anti-bacterial resistance of the skin, salt intake, edema, injury, etc.

The rash consists first of many small red papules on a mildly erythematous skin. It is accompanied by an intense prickling or tingling, not an itching. The areas affected tend to be those covered by clothing, and especially concavities on the body surface where sweat collects and is poorly evaporated, especially arms, shoulders, chest, waist, axillae, buttocks, and behind the knees. Chafing by clothing also appears to predispose to prickly heat and the condition is aggravated by exercise or heat which would otherwise cause an increase in sweating. Prickly heat interferes with adequate rest and sleep and this provokes general deterioration of health, especially where individuals must sleep in uncooled rooms. Prickly heat does occur in deserts, but it is particularly troublesome in hot humid environments.

---

[1] How remarkable that the most expert medical opinion today should echo an Anglo-Indian poem of a century ago which amusingly and at length recounted the author's diverse unsuccessful attempts to cure a case of prickly heat, ending with the lines: "Every nincompoop you meet, has a cure for prickly heat. And every single one of them is wrong!" (Kincaid 1938, p. 252).

2. Heat edema

The occurrence of heat edema is limited to unacclimatized individuals, typically from temperate climates, during the first several days of their exposure to tropical heat. It consists essentially of a swelling of the extremities, particularly the feet and ankles. The pathogenesis of heat edema is uncertain, but is probably related to the normal vasodilatory response to high temperatures, the salt and water balance, etc. Heat edema is usually transitory and is seldom incapacitating. It is presumably not seen among natives of the tropics, but the literature is not clear as to whether it occurs during hot weather in temperate zones.

3. Heat syncope

Heat syncope or heat collapse is by far the most common heat disorder. It is not related to salt or water balance, but rather to changes in the circulatory system. According to Leithead,

> The circulatory change predisposing to syncope in hot environments is peripheral dilatation, which creates a tendency to peripheral venous pooling and to hypotension. (Leithead 1964, p. 137)

Thereafter, any stress imposed by prolonged standing, by strenuous exercise, or even by sudden postural change may be sufficient to produce faintness, giddiness or syncope. Physiologically there is a collapse in vasomotor tone, exaggerated pooling, and cerebral anoxia.

The entity that is defined medically as heat syncope ranges in clinical severity from a transient sense of faintness in hot environments to collapse while exercising or working in the heat. Leithead summarizes:

> Sensations characteristically associated with syncope are weakness, light-headedness, restlessness, nausea, a sinking feeling in the epigastrium, and a desire to defecate. Yawning, blurring of vision, numbness and sensations of heat and cold have also been described. (Ibid., p. 138)

The most striking and invariable feature of heat syncope is pallor. The rectal temperature is usually above normal, but sweat is visible on the forehead and palms. After fainting, the muscles are limp and the pulse rate slow. The patient recovers consciousness within a minute or two, but usually feels the need for rest or sleep.

4. <u>Heat fatigue</u>

No clear line of demarcation can be made between extreme discomfort in heat, especially after unaccustomed and prolonged exposure, and the conditions usually referred to as "heat fatigue", "tropical fatigue", "heat neurosis", "tropical neurasthenia", etc. In his detailed study of tropical fatigue among Australian troops in World War II, Macpherson pinpointed a classic syndrome of clinical manifestations, consisting of (1) sleeplessness; (2) headache; (3) vague abdominal pain; (4) loss of appetite; (5) pains in the back; (6) loss of weight; and (7) dizziness on standing up (Macpherson 1949, p. 138). While admitting the frequency of borderline cases, Ellis believes a distinction should be made between "tropical fatigue", in which neurotic symptoms are more common than those associated with excessive sweating, and "hot climate fatigue". He believes that individuals of "indigenous races" (in tropical countries) do not suffer from the former--or at any rate, not in the same way or to the same extent, as Europeans--but do suffer from hot climate fatigue during spells of hot weather (Ellis 1953, p. 37). On the basis of lengthy experience with "hot climate fatigue" in the Royal Navy, Ellis names the following principal symptoms: Lethargy; reduced powers of concentration and sense of responsibility; irritability; and (frequently) skin diseases, excessive sweating, loss of weight; and anorexia. In fact, the Royal Navy found that epidemic occurrence of prickly heat in a ship's company was a useful indicator of the presence of hot climate fatigue as well (Ellis 1952, p. 531).

Of course, most of the symptoms of "tropical fatigue" <u>can</u> occur in the absence of severe thermal stress (witness the classic "housewife fatigue"), and Sargent, whose review article, "Tropical neurasthenia: giant or windmill?", is the most thoroughgoing analysis of the subject to date, concludes also that

> The available evidence thus fails to support the frequent claim that neurasthenia is more prevalent in tropical regions than elsewhere. Whether we consider the incidence of tropical neurasthenia or the incidence of its major symptoms, the trend is actually in the reverse direction; the incidence in the tropics is lower! (Sargent 1963, p. 288)

However, Sargent does recognize the fact of psychological or behavioral disturbances provoked by heat, especially humid heat. These consist of "impairment of mental initiative, inability to concentrate, and inaccuracy", all of which represent, in his words, "organismic disorganization" (Sargent 1963, p. 308).[1]

It has been noted that both neurasthenia and "hot climate fatigue" are characteristic of the humid tropics rather than the hot dry areas (Ellis 1953, p. 29).

> . . . these disturbances are rare in hot, dry climates but are more common in hot, humid conditions. This suggests that cool nights make bearable the heat of the desert day, whereas the relentless discomfort by day and night, possibly with loss of sleep also, in the hot, humid tropics finally causes a breakdown of the psyche. . . . The impact on the individual's morale of month after month of one furuncle after another or of a chronic intertrigo is quite disproportionate to the extent and seriousness of the local lesion. (Wyndham 1962, p. 535)

Some of the psychologically and physically debilitating stresses, deriving from insects, wind, dust, glare, etc., and inseparable from the hot climate in rural India, are described in Chapter VI. As one recent visitor to India puts it,

> These conditions never leave you alone. Some of your mind, certainly much of your nervous system, is always responding to them. (Hopcraft 1968, p. 120)

Pepler (1963) has also recently surveyed the heterogeneous and conflicting literature on the long-term effects of tropical residence on health; his admirable description of the complexity of the problem and the multiplicity of factors to be considered, defies summary here.

---

[1]Sargent also recognizes a "syndrome of organ inadequacy", distinct from hot weather fatigue and definitely not neurotic in origin, but which is provoked by hot sultry weather in temperate or tropical zones (Sargent 1963, pp. 284, 308). He prefers the term "leiodystonia" to describe this condition.

Macpherson did not carry out tests of psychological performance in his classic study, but reported that

> . . . the belief in the existence of [psychological] deterioration, with time, during service in the tropics is very widely held, and the observation of an impartial observer confirmed this belief. (Macpherson 1949, p. 143)

McRobert has said much the same thing:

> Those of us with much tropical experience feel that the newcomer stands heat well in his first season, is not quite so efficient in his second, and that in the third and succeeding seasons there is a steady decline in efficiency, but we have no scientific data to offer. (Sir George McRobert, remarks in Charters 1951, p. 176)

But we are still largely in ignorance of the real nature, dimensions and etiology of the chronic, lower-order physical and psychological disabilities which appear to be related to a long sojourn, or even to indigenous residence, in a high thermal stress environment.

B. Heat Exhaustion

"Heat exhaustion" is an imprecise term that is applied to a variety of heat disorders which range from relatively mild to lethal, and which have been subdivided into four ideal types depending upon the roles ascribed to water balance, salt balance, exercise, and perspiration. In actual practice, many if not most heat exhaustion cases are of mixed etiology and thus present a mixed clinical picture.

1. Anhidrotic heat exhaustion

This is the heat disorder most recently distinguished as a separate entity, having been identified in World War II. In fact, few cases have occurred since that time, since it appears to be largely limited to individuals such as combat soldiers who are forced to an unusual degree of continuous exposure under rigorous conditions in hot (usually hot humid rather than hot desert) regions (Minard and Copman 1963, p. 256). In a sense, this disorder is an extension of prickly heat, in which the skin lesions undergo a change and perspiration diminishes or fails in the area of the rash.

The mammillaria characteristic of anhidrotic heat exhaustion have been described by some as <u>miliaria profunda</u>. Unlike <u>miliaria rubra</u> or prickly heat there is no redness between the vesicles and little or no irritation. The skin may be lumpy and granular to the touch with the multiple pale elevations that have been likened to gooseflesh. Sweat ducts appear to be distended below the rash and there is thus a failure of delivery of the sweat to the surface. The rash is generally localized on the trunk and limbs, and the patient usually perspires freely or in excess elsewhere, i.e., on the face, palms, soles, groin, axillae, etc. Polyuria is frequently present and the face may be flushed.

Anhidrotic heat exhaustion has been found in military medical annals to affect individuals only after an exposure of four to seven months in a hot tropical climate.

> This "incubation period" may be compared with the peak incidence of prickly heat in the fourth and fifth months of residence in hot climates . . . (Leithead 1964, p. 187)

The anhidrotic heat exhaustion patient is characterized by a marked intolerance to heat, particularly at midday. When no relief from work and heat is provided the disorder generally progresses in severity, with symptoms manifested even at rest. The patient displays a loss of energy, initiative and interest. On exercise, symptoms are acute and may constitute an "attack", wherein the patient suffers from some combination of the following symptoms: a hot, tense skin; dizziness; nausea; palpitations; tachycardia; sub-sternal tightness; and rapid breathing and gasping. If the man persists in work despite these symptoms, collapse will usually occur. Even if he seeks rest and relief during the hottest part of the day, he is likely to suffer from chronic exhaustion, to become anorexic, and to sleep badly on warm nights.

2. <u>Water-depletion heat exhaustion</u>

This condition occurs among both acclimatized and non-acclimatized individuals. It results when exposure to extreme heat is combined with a critical degree of loss of liquid from the body. Many cases are involuntary, among shipwreck survivors, persons lost in the desert, prisoners, infants, enfeebled persons, etc. But other cases result from failure to drink enough water even though it is available to replace the amounts lost by perspiration and other causes.

In a temperate climate an average adult has a total daily water output of about 2600 cc., including 1500 cc. of urine, 1000 cc. of sweat, and 100 cc. in feces. In tropical conditions this water loss may increase threefold in the healthy person, even though urine is reduced. And even beyond this--especially in the newcomer to the tropics--diarrhea resulting from intestinal infection is a common cause of additional water loss. Vomiting also adds to water depletion, and a vicious cycle is frequently met with which involves dehydration, uremia, vomiting, then further dehydration, and so on (Raina 1961, p. 526).

In the early stages of water-depletion heat exhaustion, or in a mild case, the patient is simply impatient, sleepy and exhausted, and complains of vague discomfort, dizziness, lack of appetite,and tingling sensations. He is always thirsty. He has a rapid pulse and an increased rectal (body) temperature, and breathing is fast, labored, or even gasping. With the further development of this type of heat exhaustion there is intense thirst, dryness of the mouth, scanty and highly colored urine, and an impairment of judgment and mental and physical capacities (e.g., difficulty in walking). Cyanosis or a blue tinge is often apparent. The symptoms of circulatory disorder are further intensified. Eventually the patient is unable to stand or to control his muscles and may become hysterical or delirious. Heatstroke frequently intervenes, or death may occur after coma from osmotic pressure, oligemic shock, cyanosis and circulatory failure, accompanied by extreme oliguria or anuria.[1]

3. <u>Salt-depletion heat exhaustion</u>

This condition is most likely to develop in unacclimatized individuals after two or three days of moderate or heavy physical activity, resulting in a high sweat rate, in severe environmental heat, where water intake is adequate but salt replacement is not sufficient. It perhaps occurs most frequently in unacclimatized men who drink water freely but who fail to replace the salt lost in perspiration, about 4 grams per hour with hard

---

[1]Death from dehydration or water-depletion <u>in the absence</u> of high environmental heat differs from this description principally in the length of time from onset to termination, lower body temperatures, and less marked circulatory involvement.

work at 100° F. (Conn 1949, p. 376).[1] These newcomers often suffer loss of appetite, with a resultant lack of salt intake in their solid diet. Some individuals who have taken too many salt tablets at one time, causing them to vomit, develop an aversion to salt supplements and are thus susceptible. The surprisingly large individual variations in salt loss and requirements found by Ladell and his colleagues in Iraq point further to the importance of this idiosyncratic factor (Ladell, Waterlow and Hudson 1944, pp. 492-493). It is also known that fibrocystic disease of the pancreas, which produces electrolyte abnormalities, predisposes to heat exhaustion (Cook 1955, p. 320), and other subclinical conditions may have a similar effect.

Based upon over 500 cases of salt-depletion heat exhaustion, Leithead estimates the percentage incidence of symptoms as follows: fatigue, 92%; giddiness, 61%; muscle cramps, 60%; nausea, 59%; constipation, 55%; vomiting, 52%; anorexia, 50%; headache, 43%; syncope, 22%; and diarrhea, 19%. The disorder develops insidiously and progresses in about three to five days to an incapacitating stage.

The earliest symptom of salt-depletion heat exhaustion is fatigue, with initial increase of urine production, followed by decrease. The lassitude, weariness and muscular weakness is generally so profound that the patient does not wish to make even the effort of speaking. Giddiness and headache are probably due to hemoconcentration and circulatory insufficiency.

> The headache is frontal and is relieved to some extent by recumbency; giddiness and/or syncope during work or on standing up suddenly, result from orthostatic hypotension and are banished if the patient lies flat. (Leithead 1964, p. 160)

---

[1]Heat-acclimatization produces increased efficiency of the sweat glands to conserve salt. Thus, with a constant diet and a daily salt intake of 15 grams, there is a 60% - 70% decrease in the concentration of sodium chloride in sweat. And if the salt consumption is reduced to as little as 2 grams per day, sodium chloride concentration values of 0.25 grams per liter of sweat may be found, thus permitting the maintenance of salt balance with as much as 8 liters of perspiration daily (Conn 1949, p. 378).

Extremely painful heat (muscle) cramps may occur either early or late in the course of illness, but appear to be especially precipitated by a large intake of unsalted water. Each cramp lasts a considerable period of time, often one or two minutes, with the affected muscle tightly contracted. The muscles which have been exercised and fatigued are usually the first to be affected.

The symptoms of loss of appetite (anorexia) and nausea followed by vomiting which are frequently seen in salt-depletion heat exhaustion have the vicious effect of further increasing the salt deficiency. The disorder should be regarded as serious when vomiting occurs. The patient generally appears pale or "muddy-colored" and cool. The face is clammy and there is sweating, but the skin is inelastic and even dehydrated due to secondary water loss. Body temperature may be normal, subnormal, or above normal. The intermediate-stage patient maintains a moderate pulse rate while lying down, but upon standing there is a sharp increase in pulse rate and a fall in systolic blood pressure, with the likelihood of fainting or collapse.

Salt-depletion heat exhaustion, in contrast to water-depletion heat exhaustion, does not predispose to heatstroke. However, unless halted by the administration of saline solution, the condition terminates fatally with oligemic shock and coma. In the final stage,

> The skin is blanched by intense vasoconstriction, and covered with cold sweat. The pulse is shallow and rapid and the systolic blood pressure is below 100 mm Hg. (Leithead 1964, p. 163)

Modern laboratory methods allow accurate diagnosis of salt-depletion by measuring sodium and chloride levels in plasma and urine. Significant changes in the blood may also be seen, for example in hematocrit percentage, plasma protein, and blood urea. In actual practice many if not most cases of heat exhaustion involve both water and salt depletion. However, Leithead has summarized the typical differences between the two in the following table (see Table 7). Raina adds to these distinctions the assertion that dehydration in the case of water-depletion heat exhaustion is intracellular, while in the case of salt-depletion heat exhaustion it is extra-cellular (Raina 1961, p. 526).

Table 7. Distinction between predominant water-depletion and predominant salt-depletion heat exhaustion

Features	Predominant Salt-depletion	Predominant Water-depletion
Duration of symptoms	3 to 5 days	Often much shorter
Thirst	Not prominent	Prominent
Fatigue	Prominent	Less prominent
Giddiness	Prominent	Less prominent
Muscle cramps	In most cases	Absent
Vomiting	In most cases	Usually absent
Thermal sweating	Probably unchanged	Diminished
Hemoconcentration	Early, and marked	Slight until late
Urine chloride	Negligible amounts	Normal amounts
Urine concentration	Moderate	Pronounced
Plasma sodium	Below average	Above average
Mode of death	Oligemic shock	High osmotic pressure; oligemic shock; heatstroke

Source: C. S. Leithead, "Disorders due to Heat", p. 165

It may be noted that the validity of the salt-depletion heat exhaustion syndrome is still in some dispute. Shibolet and his colleagues believe it is due not so much to salt deficiency as to the inability of the unacclimatized to conserve heat (Shibolet, Gilat, and Sohar 1964, p. 37), while Sohar and Adar simply remain unconvinced that salt deficiency per se is responsible or that salt administration alone produces recovery (Sohar and Adar 1964, p. 59).

4. Heat cramps (work-induced)

As just described, muscle cramps are a frequent, although not necessarily a constant nor usually an early symptom of salt-depletion heat exhaustion. Such heat cramps, when they occur, do not differ in clinical manifestation from those here described separately. However, inasmuch as muscle cramps, following hard physical work or exercise in heat, frequently occur <u>without</u> the other symptoms of salt-depletion heat exhaustion, this condition is generally regarded as a distinct entity.

Work-induced heat cramps are known throughout the world in association with strenuous operations carried out in high climatic or industrial environmental heat and have been given appropriate popular names: stoker's cramps, miner's cramps, cane-cutter's cramps, fireman's cramps, etc. A number of factors apparently enter into their occurrence: primarily, high heat with sweating, muscle fatigue, and an as yet not fully understood individual predisposition; secondarily, the state of acclimatization and slight salt and water deficiency; and possibly one or more factors of nutritional deficiency and metabolism, perhaps potassium metabolism.[1]

Mild heat cramps of the arms or legs are so common in many places as to be regarded as an occupational hazard. They often occur at the end of the day's work--for example, in the arms while washing up, or in the legs while walking home. This suggests that cool water or air may be an immediately predisposing factor. Certainly, an attack is often preceded by a copious draught of cold water. However, frequently the first symptoms appear after several hours of work, but the laborer, not wishing to lose pay and instead of resting,continues to work until the pain is unbearable. The heat cramps can occur throughout the year (that is, even in moderate heat), but are so much more frequent in the hot season that they undoubtedly constitute a heat disorder.

The cramps may vary among individuals in their mode of manifestation, and especially in time, duration, and degree of intensity. The average spasm lasts about 30 seconds to a minute, occurring at intervals of several minutes, and the whole attack ends spontaneously after an hour or two. Severe or untreated cases can last six to eight hours.

---

[1]An interesting survey article on the heat illnesses in the WHO Chronicle raises the question of the relevance of potassium losses, when an individual has been working daily in heat and has had a high perspiration output. The article notes that potassium depletion is entirely consistent with some of the features of the heat disorders, notably weakness and lethargy, and Pitressin-resistant polyuria (WHO Chronicle 1964, pp. 295-296).

The muscles contract together, often preceded by twitching or fasciculation. The limb, abdominal and spinal muscles are of course the ones usually affected, being the ones most exercised in work. The flexor muscles of the finger are also frequently involved. Most often the victim of muscle cramps is not otherwise ill; blood pressure is often below average, and body temperature is usually normal. Heat cramps are in a sense self-limiting rather than progressive. They affect heat-acclimatized persons as readily as the unacclimatized.

Almost immediate relief from heat cramps is obtained by intravenous injection of saline solution, while the addition of salt to the diet of those individuals predisposed to attacks is an adequate preventive.

C. Hyperpyrexia and Heatstroke

1. Heat hyperpyrexia

Heat hyperpyrexia may or may not be regarded simply as the first stage of heatstroke, into which it can rapidly progress if not promptly treated. Heatstroke results from failure in the body's thermoregulatory system, and at the stage of hyperpyrexia this system is impaired, although sweating may still be present and the patient is conscious and rational. The condition of heat hyperpyrexia is clear-cut when the body temperature reaches the vicinity of 105° - 106° F. If rapid cooling is achieved at this point there may be no damage to the body and in many cases no notable symptoms beyond the high fever are present. In other cases some of the early symptoms of heatstroke may be observed even at a rectal temperature of 105° F. Whether or not the condition should be described as mild heatstroke or as severe heat hyperpyrexia may be arbitrary. One possible danger in the state of hyperpyrexia is suggested from some experimental work showing that some individuals feel a sense of well-being or euphoria in the early stages of temperature rise.

2. Heatstroke

Heatstroke is the most dramatic and dangerous of the heat disorders and, while it probably accounts for the largest number of deaths from heat, it is still relatively rare in comparison with the heat disabilities already described. In fact, Minard and Copman, in an authoritative recent survey of the medical literature, were forced to conclude that

> . . . uncontrolled hyperthermia with total absence of sweating, as seen in heat stroke, is not the usual response to extreme heat stress. Its occurrence appears to be dependent upon inherent susceptibility in a small fraction of the population. The more common consequence of intolerable heat stress is circulatory collapse with continued sweating at reduced rates and moderate or no elevation of body temperature. (Minard and Copman 1963, p. 257)

There is still a great deal of disagreement in the medical literature as to the classification (and even the spelling--witness "heatstroke", "heat-stroke", and "heat stroke"!) of the disorder. Minard and Copman define it as

> . . . a disorder of thermoregulation characterized by total absence of sweating, a self-perpetuating hyperthermia usually of 41.1° C. (106° F.) or higher, and severe disturbances of consciousness and brain function. (Ibid., p. 256)

They believe it is important to distinguish this syndrome from conditions of hyperthermia and collapse, or so-called "incipient heatstroke".

In the earlier literature heatstroke was often referred to as "heat apoplexy" or as "sunstroke", terms which no longer have medical currency. Although it has been found that the tropical sun can produce local heating of hair and skull to a depth of 1 or 2 cm. of the skull surface, hair and tissues (Manson-Bahr 1965, p. 341), the accepted view today is that no difference exists in the clinical and pathological features of heatstroke occurring in a shaded hot environment and that occurring subsequent to exposure to fierce solar radiation.[1]

---

[1] But Glaser, citing the work of Malmejac and his associates, has recently suggested the possibility that the overheating effect of a high radiant heat load on the skin may bring about release in the skin of toxic breakdown products which may lead to generalized vascular responses contributing to circulatory failure (Glaser 1963, p. 137).

Many factors are known or hypothesized to predispose to heatstroke occurrence in addition to the major one of excessive heat exposure:

1. A recent attack of anhidrotic heat exhaustion or water-depletion heat exhaustion.
2. Lack of acclimatization.
3. A previous history of heat intolerance.
4. Sweat gland fatigue, or the presence of prickly heat or other skin disease which impairs sweating.
5. Intercurrent disease or fever, including reaction to inoculation.
6. The administration of pyrogenic agents such as typhoid vaccine, or of drugs which inhibit sweating, e.g., the belladonna alkoloids such as atropine, hyoscine, and scopolamine.
7. Dehydration.
8. Consumption of alcohol.
9. Age (cardiovascular degeneracy in the middle-aged and elderly and vulnerability to water depletion plus possible thermoregulatory inadequacy in the newborn).
10. Skin pigmentation.
11. Improper clothing.
12. Constipation.
13. Environmental conditions where there is no relief day or night from the heat.
14. Poor physical condition (which may be enhanced by lack of sleep).

However, much research remains to be done if these factors are to be even roughly quantified. A previous episode of heatstroke is usually considered to be a predisposing factor. Yet, as Napier puts it,

> . . . the statistical evidence on this point might mean nothing more than that those who have had one attack are constitutionally ill-fitted to withstand high temperatures and are therefore likely to suffer again. (Napier 1943, p. 36)

The course of heatstroke, especially in the absence of cooling treatment, is very rapid. It is usually ". . . a catastrophe of sudden and unheralded onset", to quote Leithead (1964, p. 203), and can result in death within an hour or two. Leithead believes it is not yet certain whether anhidrosis precedes or follows hyperpyrexia, and the WHO Chronicle concludes that either sequence is possible in given cases, but others are definitely of the view that arrest of sweating is a consequence rather than a cause of heatstroke (Shibolet, Gilat and Sohar 1964, p. 36). At any rate, a failure in the production of sweat typically if not invariably accompanies the disorder. This contrasts with anhidrotic heat exhaustion, where there is a failure of delivery of sweat to the skin surface but not a cessation of sweat production. Some authorities feel that the cause is to be sought in the central nervous system or in changes in the circulatory system, especially a rising venous pressure following high-output cardiac failure. Leithead, however, points to the phenomenon of fatigue of the sweating mechanism as a more probable cause of anhidrosis in most cases.

The heatstroke victim is sometimes aware that he has stopped sweating and feels extremely hot with a flushed, dry skin.[1] Moderate to severe headache is frequently an early symptom, as well as dizziness and numbness or drowsiness. A distinctive characteristic of heatstroke is disturbance of the central nervous system, manifest in restlessness, a staggering gait, purposeless and uncoordinated movements, aggressiveness, mental confusion, delirium, mania, epileptiform convulsions, and coma. Body temperatures generally range from 105° to 108° F. at an early stage and from 108° to 113° F. at the stage of convulsions or coma. Similarly, the pulse rate increases typically to 130 beats per

---

[1]Overworked Royal Army doctors, serving in the Middle East in World War I at a time (July 7 - August 11, 1917) when literally thousands of soldiers were hospitalized by heat effects, soon developed a rule of thumb enabling them readily to differentiate those men in danger of fatal heatstroke. These would cry for the fans to be turned off, since the hot wind being circulated would create an additional heat load on anyone with a dry skin, who had stopped sweating. But men who were still sweating cried for the fans to be kept on, as the moving air cooled them by evaporation (Willcox 1920, p. 399).

minute at first and to 160 beats per minute or more at 108° F. body temperature. The skin, although not inelastic as in salt-depletion heat exhaustion, is hot and dry, and sweating is totally absent over the whole body.

Other features are more variable in their presentation but occur frequently: fixed eyes with constricted or dilated pupils; cyanosis of the lips and face; blotchiness or rash; petechiae and ecchymoses on the upper part of the body: vomiting; incontinence of urine and watery feces; hyperventilation or stertorous snoring breathing; and tetany. Considerable variation is found from one case to another in the circulatory system--pulse rate and quality, blood pressure, etc. The clammy skin, low blood pressure, and feeble pulse of shock are not seen in heatstroke, except sometimes at a late stage, and are certainly a poor prognostic sign. Respiration is rapid, from 35 to over 60 per minute, and in the final stages of heatstroke it may become Cheyne-Stokes in type.

Besides numerous idiosyncratic variations, symptomatic aspects of heatstroke vary depending on whether the patient receives immediate treatment or has lain untreated for several hours. Malamud and his colleagues conducted a classic study of 125 U. S. military heatstroke deaths, from which there emerged a typical causative pattern of reciprocal reinforcement, or vicious circle:

1. The precipitatory cause is excessive body heat;
2. Excess body heat incapacitates the heat-dissipating mechanism;
3. As a result sweating ceases, causing greater accumulation of heat in the body;
4. The increasing metabolism of a higher body temperature adds further fuel to the flames; and
5. Sooner or later shock ensues and, owing to peripheral vasoconstriction, further augments the body temperature (Malamud, Haymaker and Custer 1946, p. 447).

Even if the shock is brought under control, the damage from hyperthermia may have been done. Wyndham more specifically pinpoints the irreversible body changes in heatstroke which lead to death:

> These changes are of two kinds. In one the circulatory system goes into profound shock and none of the present

> anti-shock measures cause the blood pressure to rise; the other is specific heat damage to cerebral tissue--patients die with a good circulation but in deep coma or wild delirium. (Wyndham 1962, p. 538)

Autopsy of heatstroke victims reveals an unusual amount of hemorrhage, interstitial fibrosis, congestion in the body organs, etc. It is well known that rigor mortis appears early in heatstroke victims. Malamud's group was unable to confirm hemoconcentration as a regular feature of heatstroke, however. Probably cardiovascular health affects both susceptibility and survival, since

> . . . on the few occasions it has been attempted, electrocardiography in young men with heat stroke has shown impressive degrees of myocardial damage . . . (WHO Chronicle 1964, p. 291)

Immediate cooling by any means available--ice-bath, cool water spray, fanning, and the like--has long been recognized as the standard treatment of heat hyperpyrexia and heatstroke. The ice-bath has recently been attacked as unphysiological, however, and Hoagland and Bishop recommended cooling by wet towels and fans together with chlorpromazine and other drug treatments.

> We advise against <u>any</u> use of ice, cold water, or any other form of cryotherapy. We recommend intermittent sponging with water at room temperature. (Hoagland and Bishop 1961, p. 421)

Chlorpromazine has been found an effective adjunct to cooling treatments in trials in India (Berry, Subhedar and Bhargava 1961) and in China (Yen *et al.* 1958), since it reduces hyperthermia by central and peripheral actions, prevents shivering, and produces vasodilatation. Ferguson and O'Brien believe that the hypothermic blanket may replace the ice bath as the treatment of choice in well-equipped hospitals (Ferguson and O'Brien 1966, p. 900). Minard and Copman conclude that medical opinion is still somewhat evenly divided between the proponents of conductive cooling in an iced bath and those who favor evaporative cooling in wet sheets and by air circulation. In both cases vigorous massage is required to maintain cutaneous circulation.

Some of the most recent observations on heatstroke--not yet published--are those of Major Victor Johnson of the Walter Reed Army Medical Center, Washington, D. C., who studied heatstroke in South African gold mines (Johnson 1965). These mines, unless they are artifically cooled and ventilated, have a temperature of 105° F. at 10,000 ft. depths and 120° F. at 11,000 ft. Recently some mines have reached 13,000 ft. (Folk 1966, p. 142). Johnson found that almost all heatstroke casualties occurred either within the first three hours of the work shift or else just near the end of the shift, with very few cases between. The cases of heatstroke occurring at these two times also seemed to be of different types. Those at the beginning of the day are less numerous, but more frequently fatal. In most cases the affected worker is coming down with some virus or sickness. The heatstroke cases at the end of the day may differ in part because the worker has not eaten for 18 hours or so, and many result because a gang foreman, usually for reasons of antipathy, pushes the man just a little harder than usual.[1] In all cases of heatstroke, Johnson found that cardiograms and electroencephalography revealed distinctive patterns and lesions. In the South African mines--and this is a finding that can probably be generalized to wherever large numbers of heatstroke cases occur among health men in the prime of life--

> . . . the subjects showing least subjective strain are perhaps the most likely candidates for heatstroke. (Minard and Copman 1963, p. 257)

This is because heatstroke seems most likely to occur in those persons

> . . . whose body temperature has already reached a high level but who, though feeling no discomfort, continue to work, resulting in still further rise in body temperature, until the heat regulating mechanism completely fails. (Dreosti 1935, p. 108)

---

[1]Lind has recently investigated the puzzling circumstance that the heatstroke rate among coal miners in Belgium, Germany, and the U. K., working up to an environmental limit of 83° F. Effective Temperature, has been enormously lower than that among the South African gold miners at comparable levels of heat stress. Having ruled out age, race, state of acclimatization, and total hours or work as possible explanations for the near-absence of heatstroke among the European miners, he concludes that "non-physiological factors", principally the existence in Europe of strong labor unions which effectively prevent too high a work rate being enforced by disciplinary control, are responsible for the much higher heatstroke rate in South Africa (Lind 1970, p. 464).

LIST OF REFERENCES

Berry, J. N., Subhedar, B. J. and Bhargava, H. S. 1961. "A controlled trial of chlorpromazine in the treatment of hyperpyrexia", Journal of the Association of Physicians of India, Vol. 9, pp. 747-757

Charters, A. D. 1951. "The effect of climate on the health of Europeans in the Kenya highlands", East African Medical Journal, Vol. 28, pp. 174-188, 204-213

Conn, J. W. 1949. "The mechanism of acclimatization to heat", Advances in Internal Medicine, Vol. 3, pp. 373-393

Dreosti, Aldo O. 1935. "Problems arising out of temperature and humidity in deep mining on the Witwatersrand", Journal of the Chemical, Metallurgical and Mining Society of South Africa, Vol. 36, pp. 102-109

Ellis, F. P. 1952. "Thermal comfort in warm, humid atmosphers. Observations in a warship in the tropics", Journal of Hygiene, Vol. 50, pp. 415-432

_____. 1953. "Tropical fatigue", pp. 21-39 in Tropical Fatigue (W. F. Floyd and A. T. Welford, eds.). London: H. K. Lewis and Co.

Ferguson, Matthew J. and O'Brien, Sister Michael Marie. 1966. "Heat illness--the neglected disease", Medical Times, Vol. 94, pp. 897-902

Folk, C. Edgar. 1966. Introduction to Environmental Physiology. Philadelphia: Lea and Febiger

Glaser, E. M. 1963. "Circulatory adjustments in the arid zone", pp. 131-151 in Environmental Physiology and Psychology in Arid Conditions. Reviews of Research. Paris: UNESCO

Hoagland, R. J. and Bishop, R. H. Jr. 1961. "A physiological treatment of heat stroke", American Journal of Medical Science, Vol. 241, pp. 415-422

Hopcraft, Arthur. 1968. Born to Hunger. Boston: Houghton Mifflin

Johnson, Victor. 1965. Heatstroke in the South African Gold Mines. Seminar presented to the U. S. Army Research Institute of Environmental Medicine, 5 March 1965 (unpublished)

Kincaid, Dennis. 1938. British Social Life in India, 1608-1937. London: G. Routledge and Sons

Ladell, W. S. S., Waterlow, Y. C., and Hudson, M. F. 1944. "Desert climate, physiological and clinical observations", Lancet, Vol. 247, pp. 491-497, 527-531

Lambert, A. 1897. "Sunstroke as it occurred in New York City during 1896", The Medical News, Vol. 71, pp. 97-

Leithead, C. S. 1964. "Disorders due to heat", pp. 125-236 in Heat Stress and Heat Disorders (C. S. Leithead and A. R. Lind). Philadelphia: F. A. Davis

Levick, James J. 1859. "Remarks on sunstroke", American Journal of Medical Science, Vol. 37, pp. 40-55

Lind, A. R. 1970. "The lack of heatstroke in European miners working in hot climates", American Industrial Hygiene Association Journal, Vol. 31, pp. 460-465

Macpherson, R. K. 1949. Tropical Fatigue. Brisbane: University of Queensland Press

Malamud, N., Haymaker, W., and Custer, R. P. 1946. "Heat stroke. A clinical-pathologic study of 125 cases", Military Surgeon, Vol. 99, pp. 397-449

Manson-Bahr, Sir Philip H. 1965. Manson's Tropical Diseases. London: Bailliere, Tindall and Cassell (16th ed.)

Minard, David and Copman, Louis. 1963. "Elevation of body temperature in disease", pp. 253-273 in Temperature: Its Measurement and Control in Science and Industry (James D. Hardy, ed.). New York: Reinhold Publishing Corp.

Napier, L. Everard. 1943. The Principles and Practice of Tropical Medicine. Calcutta: Thacker, Spink and Co.

Pepler, R. D. 1963. "Performance and well-being in heat", pp. 319-336 in Temperature: Its Measurement and Control in Science and Industry (James D. Hardy, ed.). New York: Reinhold Publishing Corp.

Raina, Bishen Lal (ed.). 1961. Official History of the Indian Armed Forces in the Second World War 1939-45. Preventive Medicine (Nutrition, Malaria Control and Prevention of Diseases). Delhi: Combined Inter-Services Historical Section, India and Pakistan

Sargent, Frederick II. 1963. "Tropical neurasthenia: giant or windmill?", pp. 273-314 in Environmental Physiology and Psychology in Arid Conditions. Reviews of Research. Paris: UNESCO

Shepherd, H. M. D. 1945. "Effects of heat in Iraq", Journal of the Royal Army Medical Corps, Vol. 84, pp. 1-8

Shibolet, S., Gilat, T., and Sohar, E. 1964. "Physical effort as main cause of heat-stroke", pp. 33-39 in Environmental Physiology and Psychology in Arid Conditions. Proceedings of the Lucknow Symposium. Paris: UNESCO

Sohar, E. and Adar, R. 1964. "Sodium requirements in Israel under conditions of work in hot climate", pp. 55-62 in Environmental Physiology and Psychology in Arid Conditions. Proceedings of the Lucknow Symposium. Paris: UNESCO

Wakefield, E. G. and Hall, W. W. 1927. "Heat injuries: a preparatory study for experimental heat stroke", Journal of the American Medical Association, Vol. 89, pp. 92-95

WHO Chronicle. 1964. "Heat illness", WHO Chronicle, Vol. 18, pp. 283-304

Willcox, W. H. 1920. "The nature, prevention and treatment of heat hyperpyrexia", British Medical Journal, n.s. Vol. 1, pp. 392-399

Wyndham, C. H. 1962. "Research needs in tropical climatology", pp. 533-540 in Tropical Health. Washington, D. C.: National Research Council. National Academy of Sciences

Yaglou, C. P. and Minard, David. 1957. "Control of heat casualties at military training centers", A. M. A. Archives of Industrial Health, Vol. 16, pp. 302-316

Yen, H. C., Lu, H. H., Yuan, P. H., Wu, H. N., and T'ang, H. C. 1958. "Chlorpromazine and heat-reducing measures in treatment of heat stroke", Chinese Medical Journal, Vol. 77, pp. 174-177

APPENDIX C

THE HEAT STRESS INDICES AND THEIR INTERPRETATION

> "One of the problems for a student of thermal physiology has been a confusion of symbology and terminology in the literature [and] the confusion is likely to persist because there is no agreement on how to calculate stress (or even how to calculate heat exchange ratios)."[1]

A. The Indices

The history of scientific attempts to understand and evaluate heat stress and heat strain[2] must be read from a large and variegated literature, but has been well summarized by Macpherson (1962), Lind (1964b), Fox (1965), and Leithead (1968), among others. Macpherson described some 19 different heat indices which had been developed up to 1960; several more have been added since then, but the leading experts in this field accept none of them without some reservations:

> Only a few heat stress indices have any real practical value and are in common use. Each has its merits and its drawbacks . . . (Lind 1964a, pp. 171-172)

---

[1]Jack E. Peterson, "Experimental evaluation of heat stress indices", p. 306

[2]The distinction should be made here--even if it has possibly not been always rigorously respected throughout the text of this report--between heat stress, which refers to the total heat load imposed on the body by all factors--environmental, clothing, and metabolic--and heat strain, which refers to the physiological and at times patho-physiological displacement resulting from the heat stress (Hatch 1963, p. 307; Leithead 1967, p. 739). Löfstedt has invented a clever pictorial representation of these two concepts, explaining the dynamics as follows: "The heat stress must be balanced by a corresponding sweat rate. This is obtained by increasing the body temperature. The sweat rate thus balances the heat stress and is a physiological measure of it. However, it does not tell how much strain is involved to bear the load. The strain is better indicated by body temperature." (Löfstedt 1966, p. 53)

> We can say that all are more or less useful for certain purposes and that none are universally applicable. (Belding 1958, p. 40)

> Despite all the thought which has been given to the matter, there is no really satisfactory index or scale for assessing the effects of the wide variety of combinations of air temperature, humidity, air speed, radiant heat, clothing, work rate and duration of exposure which may be encountered in the tropical, or any other, environment. (Ellis 1962, p. 528)

> It is . . . clear that the ideal index for assessing the heat load imposed on man in a hot situation and for predicting the resultant physiological strain is still lacking . . . (Fox 1965, p. 63)

Macpherson grouped the various heat stress formulas into three main classes:

> . . . those which are based on the measurement of the physical factors in the environment, those which are based on a measurement of the physiological strain produced by the environment, and those based on the calculation of the heat exchange between the body and its environment. (Macpherson 1962, p. 159)

This is a categorization which we can also attempt to follow, although some indices tend to be hybrids. To some extent, these three ideal types of indices reflect the approaches or the interests of different scientific disciplines, namely: (1) meteorology-climatology; (2) physiology, including psychological physiology; and (3) physics-biophysics.

1. Environmental Indices

Man's first measurement of heat, the simplest and still the single most important one, is dry bulb temperature, often referred to as "air temperature" or t_a. The earliest accurate mercury thermometer is credited to Fahrenheit (in 1714), following by a century the more primitive ones devised by Galileo. However, dry bulb temperature, taken alone, can be a very deceptive measure of discomfort or of heat strain. Thus, for short periods a fit man can endure enormously high air temperatures,[1] provided only that the air is completely dry. For example, 200° F. in dry air might be tolerated for half an hour about as easily as an air temperature of 100° F., slightly above that of the body, when the surrounding air is fully saturated with water vapor.

The first step in the direction of a multi-factorial thermal measurement was the wet bulb temperature, a figure which combines the temperature and humidity of the air.

> The wet bulb reading for any air condition . . . is the lowest temperature which may be realized by a wetted surface due to heat loss by evaporation. (Ferderber and Houghten 1941, p. 475)

Again quoting Macpherson,

> Its use as an index of thermal stress is largely due to Haldane (1905) who was convinced, as the result of work on conditions in hot, wet mines in Cornwall, that the wet-bulb temperature provided the best measure of the physiological effects of hot environments. (Macpherson 1962, p. 153)

It must be noted, however, that wet bulb temperature ordinarily implies a fully aspirated reading, i.e., the reading is made after high air ventilation, typically accomplished by swinging a sling psychrometer. Thus, the wet bulb figure reflects the lowest temperature obtainable by bringing air movement to a maximum constant effect. When a non-aspirated wet bulb temperature is used--as it is in some heat indices, such as the WBGT--it results in a figure that varies depending on air movement, but one that of course is never lower than the psychrometric or aspirated reading. The argument for such a non-aspirated reading is that man is responsive only to the natural convective evaporation, not to the maximal evaporation of the slung wet bulb. In any event, at wind speeds over about 7 mph the difference is negligible (Goldman 1971).

---

[1]In 1775 two English doctors stayed in a room heated to a dry bulb temperature of 260° F. for 13 minutes without apparent discomfort or rise of body temperature, while a beefsteak was well cooked (assisted by blowing air on it with a bellows), and an egg roasted hard (Blagden 1775).

In the 1920's Houghten, Yagl(ogl)ou, and their colleagues at the Research Laboratory of the American Society of Heating and Ventilating Engineers[1] in Pittsburgh developed what was perhaps the first true heat discomfort index, which has continued to be used to the present time. This is the "Effective Temperature Scale", or ET.

> . . . Effective Temperature in reality is not a temperature at all, but merely a relative index of the temper of atmospheric conditions felt by the human body in response to the physical factors of the air. (Ferderber and Houghten 1941, p. 477)

It was derived from the experimental comfort-discomfort responses of a panel of trained observers shuffled between adjacent test chambers where different but precisely known combinations of dry bulb and wet bulb temperatures and wind speeds were provided. The result of this work was a "line of equal comfort", plotted on a psychrometric chart (see Figure 10), defining the overall thermal sensation equivalents of the various environmental combinations. The numerical values of the ET scale were derived from the point of intersection of the equal comfort line with the dew-point line (Houghten and Yagloglou 1923, p. 170).

Originally devised as a sensory scale of warmth, the ET scale was subsequently believed by the ASHRAE workers to be valid also as a measure of heat stress and of physiological strain. The original work resulted in a "basic scale", standardized on subjects at rest and stripped to the waist, and a "normal scale", applying to individuals normally clothed and "slightly active". Over the years a number of modified ET scales were developed taking into account such complicating factors as differences in clothing worn and varying amounts of muscular activity or energy expenditure (e.g., Smith 1955).[2] Although these are seldom used today, it was only after long experience that workers realized that completely still and saturated air is too artificial a condition on which to base valid criteria of sensations, and thus the latest revised ET is now based on a low air velocity (ASHRAF 1965; Angus 1968, p. 21). In addition,

---

[1]Since renamed the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).

[2]See Nevins _et al_. 1966 for a review of the many ET scale modifications over the years.

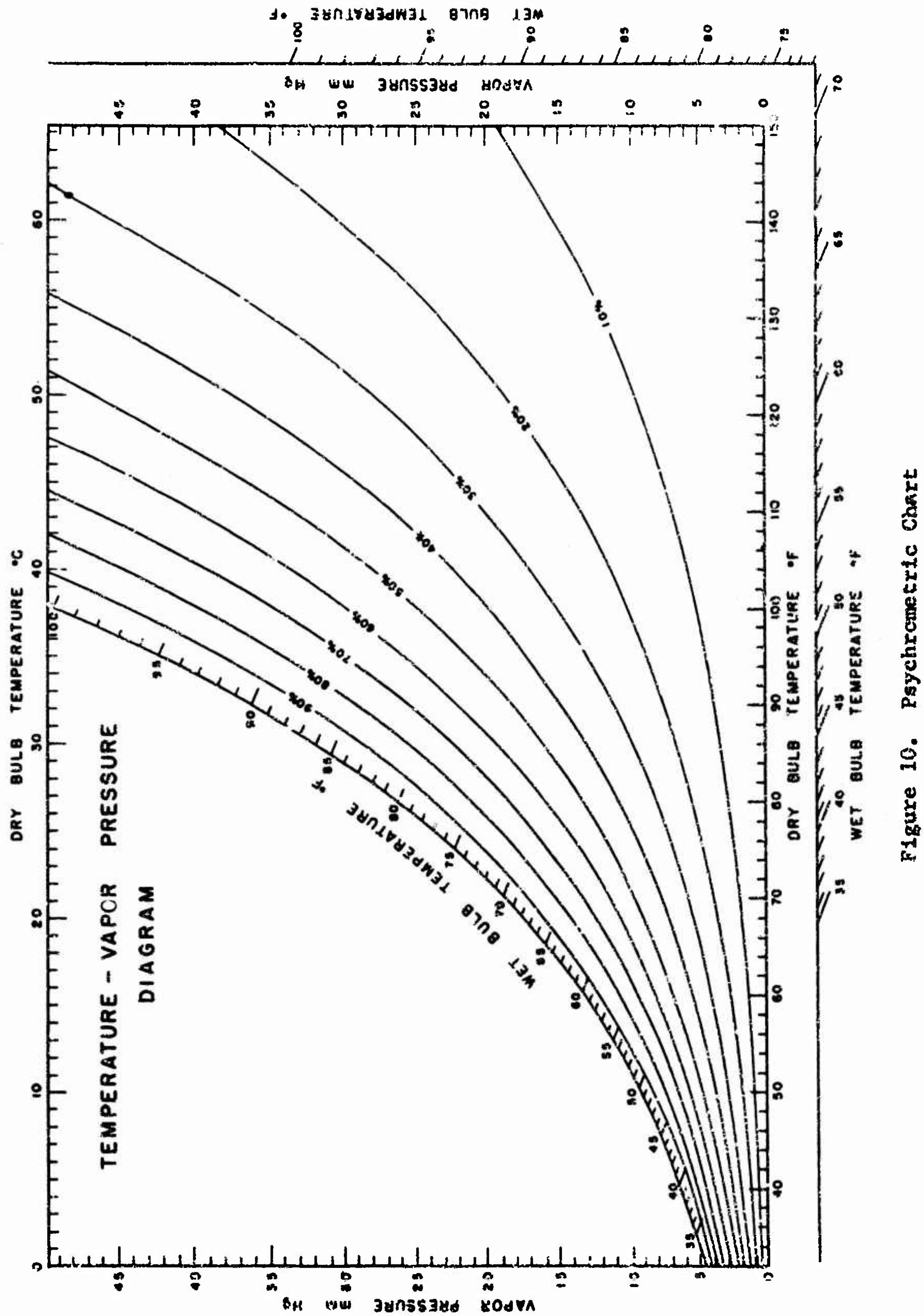

Figure 10. Psychrometric Chart

some workers in this field, for greater convenience in expressing comfort values in certain situations, have shifted to a dry bulb base with an assumption of a 50% (± 20%) relative humidity (Goldman 1971).

A veritable barrage of criticisms of the Effective Temperature scales has been laid down by physiologists.[1] Most of them boil down to the following, according to Sargent and Zaharko (1962, p. 180):

1. underestimation of effect of air stagnation, or lack of air movement, in hot humid conditions;
2. overestimation of effect of air speeds over 100 fpm at high dry bulb temperatures;
3. underestimated importance of wet bulb temperature in hot environments; and
4. no allowance for metabolic work performed.

Leithead warns that, in particular, the ET (and CET) scales should not be used in relation to heavy work, nor in conditions of low humidity (Leithead 1967, p. 740).

By way of background to the next step in evolution of Effective Temperature, it must be noted that about 1930 the Vernon black globe thermometer was designed as an improved meteorological instrument for measuring the combined effect of air temperature and the "radiant temperature". Radiant temperature incorporates the thermal effect of any surrounding radiant source--walls, furnaces, the sun, etc.--whose temperature is at large variance from the air temperature per se. Being unaspirated, the black globe thermometer is also affected--and deceptively so in cooler temperatures--by convective exchanges with the air. Taken alone, it is thus not a reliable indicator of heat stress.

Since the ET scales as developed in Pittsburgh took into account only air temperature and not the temperature of the surroundings, the black globe thermometer was soon recognized as a possible means to improve the ET scales for use in mines, boiler rooms, open fields, etc.--the very places where heat injuries are frequently suffered. Bedford thus proposed a "Corrected Effective Temperature" (CET) scale, based on use of a black globe thermometer reading as a direct substitute for the dry bulb temperature (Bedford 1946). Shortly thereafter, Yaglou and his co-workers also

---

[1]See, for example, Smith 1955, Lind and Hellon 1957, Macpherson 1960, Wyndham et al. 1963, Lee 1964, and Buskirk 1970.

utilized a black globe thermometer in order to obtain a radiation-corrected value, which they called "Equivalent Effective Temperature Corrected for Radiation", or ETR. The only respect in which this differed from Bedford's CET was in making a correction for wet bulb temperature also, employing an equivalent wet bulb temperature value derived from calculating dry bulb temperature and dew-point on a psychrometric chart.

In its improved form, the globe thermometer is a hollow, thin-walled copper sphere standardized to a 14 cm. diameter which gives "a similar ratio to that of man for the radiant heat gain to convective heat loss from its heated surface" (Goldman 1969, p. 7). The temperature reading is taken at the center of the globe. It has been found, however, that the black globe thermometer gives too high a reading in sunlight, because of short-wave radiation (Woodcock, Pratt, and Breckenridge 1957). Because of this, and in order to give a better simulation of the actual reflective and absorptive nature of human skin, especially of Caucasoids,[1] USARIEM biophysicists have recommended the use of a light gray rather than a black thermometer (Ibid., p. 8).

By way of quick review, some other approaches to the measurement of the measurement of the combined effect of meteorological factors on the human organism, which have largely fallen by the wayside or have been superseded by something better, are the following:

1. The kata thermometer, devised by Hill about 1913, and improved by Bedford and Warner in 1931. They sought to measure environmental cooling power by calculating the time required for the thermometer to fall from 100° to 95° F., after it had been heated to over 100°.

2. The "Equivalent Temperature" or "Equivalent Warmth" scale, produced by Bedford in 1936, following the lead of Dufton (1932), who based his measurements on a blackened copper cylinder called a "eupatheoscope";[2]

3. In France, Missenard's scale of "Resultant Temperature", an index very much like the ET or Effective Temperature; and

---

[1]For a comparison of racial or pigment-variant human skins in terms of short-wave radiation reflectance differences, see ASHRAE 1965, p. 105.

[2]Neither the eupatheoscope or the "resultant thermometer" is any longer being manufactured (Angus 1968, p. 11). The kata thermometer is not now used to measure heat stress, but several varieties of it are still available for other specialized uses. One type has a silvered bulb, making it immune to radiation effects (Ibid., p. 24).

4. The thermo-integrator, another blackened copper cylinder, developed at the John B. Pierce Foundation Laboratory at New Haven, Conn. in the course of partitional calorimetry.

Turning now to a separate line of development, emanating from the meteorological field, the April 1959 issue of Weatherwise contained two articles describing "humiture" and "discomfort index", new terms or indices designed to represent heat stress. "Humiture" was a word coined in 1937 by an amateur meteorologist, O. F. Hevener, and it subsequently enjoyed some following as a result of adoption by a number of radio and television weather reporters. "Humiture", as popularly used, was derived from the formula:

$$\text{Humiture} = \tfrac{1}{2}\ \text{dry bulb temperature} + \tfrac{1}{2}\ \text{relative humidity}$$

Hevener recognized that humiture could have been made a more accurate measurement of heat discomfort if wet bulb temperature had been used instead of relative humidity (Hevener 1959, p. 84). However, he chose the latter expression in deference to its greater familiarity to the general public.

During the 1930's and 1940's the numerous American operating utilities, air conditioning firms, and so forth, followed a variety of ad hoc or empirical formulas for defining thermal comfort or discomfort in order to predict and measure the cost of electric current required for air conditioning in hot weather. Although the ASHRAE's Effective Temperature scale was widely accepted as the best measure thus far available for measuring thermal comfort,

> Effective temperatures, as such, are not easy to secure from currently observed data, and for practical purposes effective-temperature normals cannot be secured from the existing punched cards which record the weather conditions of past years. (Thom 1959, p. 57)

Therefore, about 1957 E. C. Thom at the U. S. Weather Bureau evolved a formula which would give reasonably close approximations to the ET scale by using only dry bulb and wet bulb temperatures, without reference to the rather complicated ET nomogram. He referred to this as the "Discomfort Index" (DI), and obtained it as follows:

$$DI = 0.4\ (T_d + T_w) + 15$$

The U. S. Weather Bureau subsequently renamed this index the "Temperature-Humidity Index" or THI and has continued to popularize it as a convenient gauge of heat stress applicable to large populations and derivable from relatively standard meteorological observations. While individuals vary greatly in this respect, on average in the northern U. S. A. some people begin to respond "uncomfortable" rather than "comfortable" when the DI or THI rises to 70 (°F.), and 50% report discomfort at a THI of 75. At about 79 over 99% of the people are uncomfortable.

It must be emphasized that these statistical norms are approximately correct only for the United States, or indeed only the cooler parts of the country, since populations are always more or less locally acclimatized. Thus, a much larger proportion of the people in Portland, Maine or in Portland, Oregon experience discomfort at a THI of 75 than is the case among a representative sample or residents of New Orleans, La. The percentage of heat discomfort votes at identical THI figures among the same North American population is also much greater in May than in August after people have developed a degree of heat acclimatization. Although it is widely used in defining the point at which offices may be closed and employees sent home (e.g., usually at a THI of 83 in the Boston, Mass. area, but at 86 in Washington, D. C.), the THI does not pretend to reflect physiological strain with precision.

Essentially, the scales that have been described were developed from research using temperate zone populations. In the belief that the ET scale did not give the best assessment of tropical conditions and populations, C. G. Webb developed a comparable scale and nomogram, the Singapore Index (Webb 1959). This involved the environmental parameters of dry bulb and wet bulb temperatures, and air velocity. Subsequently, physiological parameters of perspiration onset and rate were added, and an improved nomogram was devised and given the name "Equatorial Comfort Index" or ECI (Webb 1960).

Another interesting approach to bioclimatological measurement has been derived from the old thermodynamic concept of enthalpy, and has been used notably by D. Brazol in Argentina (Brazol 1951, 1954) and by various European biometeorologists (see Gregorczuk 1968). They have applied enthalpy, or "total heat content of the air", as an index to show in a single value the combination of air and water vapor above an arbitrary zero point. The unique quality of the enthalpy figure is that it is expressed in the same physical unit (kcal/kg) as the human metabolic rate, which is usually described in kcal/kg/hr.

The historically high incidence of heat syncope, hyperpyrexia, and heatstroke in military training, where men are engaged in the most strenuous work while exposed to the sun, gives ample evidence of the real importance of the factors of energy expenditure and of solar radiation in contributing to the total heat stress. With respect to the latter, some promise of precision in the calculation of the heat load attributable to solar radiation has been given with the development of more sophisticated instruments, such as the "panradiometer" (Richards, Stoll, and Hardy 1951). But the physical properties of solar and thermal radiation and their impact on the human body constitute a highly technical and complex subject (see Blum 1945a, 1945b, 1964), and the problem of their translation into sentient temperature or heat-effect equivalents has been studied notably by Lee and Vaughan (1964) and Roller and Goldman (1967).[1]

Several years ago, Majumdar and Sharma in India boldly declared that it is of little practical value to try to compute solar heat load from the raw data (distance of the sun, latitude and altitude of the place, time of the day and year, degree of dustiness and cloudiness of the atmosphere, etc.), not just because of the complicated procedures that are required,

> . . . but also due to the multitude of uncertain factors, notable among them being the degree of cloudiness, scattering coefficient of the sky, reflection coefficient of the terrain and the state of dryness or wetness of the atmosphere throughout the path of the direct rays. (Majumdar and Sharma 1960, p. 40)

They concluded that, at least for the erect posture, a quite satisfactory approximation of solar heat load on man can be derived from use of a black globe thermometer, suitably corrected for color of clothing or complexion of the skin. However, the intervening years have seen the perfection of such improved convection-free electronic radiometers as the R-Meter, developed at the J. B. Pierce Laboratory (Gagge et al. 1968) and Braun and McNall's thermoelectric radiometer (Braun and McNall 1969). It is possible that some of these may meet the Indian scientists' objections, although most were developed for indoor rather than outdoor use.

---

[1]While there is some question as to the comparability of thermal effects of solar rays and of radiant heat sources studied in indoor laboratories, Suggs has recently calculated that, in warm climates, a 7 F.° increment in radiant heat load is equivalent, in terms of heart rate response, to a 1 F.° increment in dry bulb air temperature (Suggs 1965, p. 1000).

In connection with the problem of prevention of heat casualties in U. S. Marine Corps training centers, Yaglou and Minard in 1954 began their studies by carefully recording the four factors which jointly determine the ambient thermal environment: air temperature, air movement, humidity, and radiation. These were then converted to an ETR, or "effective temperature corrected for radiation" value (see p. 415). But since they found that olive-drab uniforms absorb only about 78% as much solar radiation as would clothing of the color of the black globe thermometer, the original scale was slightly modified. Recognizing that the accurate determination of Effective Temperature, especially of the air movement component, is a time-consuming and elaborate procedure, and not well suited to rapid outdoor calculation, Yaglou and Minard attempted to develop a convenient and accurate substitute. Their replacement, and one that has now come to be widely adopted for rapidly assessing heat stress in field conditions, is the "wet bulb globe temperature index", or WBGT. The close fit between effective temperature (corrected for radiation) and the WBGT figures has been verified in other studies. Davies, for example, found a 0.95 correlation coefficient between CET and WBGT over a wide range of hot conditions aboard ships (Davies 1963).

Yaglou and Minard's original formula for WBGT (0.7 psychrometric wet bulb temperature + 0.3 black globe temperature) was weighted for olive-drab clothing and also used a ventilated wet bulb reading. Subsequent investigations (notably Peters 1966) indicated that the WBGT could be obtained even more conveniently, with practically no sacrifice of accuracy under most field conditions, by using a non-aspirated wet bulb reading. The WBGT formula was thus ultimately refined to the following (see Hislop 1960):

$$\text{WBGT} = 0.7\ (\text{non-psychrometric})\ T_w + 0.2\ T_g + 0.1\ T_d$$

New instruments have been developed which automatically integrate wet bulb, globe, and dry bulb thermistors and read out the resultant WBGT index. Most of these are electronic (Peters 1966, p. 8), but Canadian workers have recently described a direct-reading mercury thermometer for the WBGT, which actually functions as a fluid analogue computer:

> The principle used in this instrument, based on the common mercury-in-glass thermometer, is that the internal volumes of the wet bulb, the bulb of the globe thermometer, and the dry bulb are made in the ratio of 7:2:1 respectively, and all three are connected to a common stem in which the meniscus of a thermally expansible fluid contained in the system can be read as in an ordinary thermometer. (Taylor, Kuehn, and Howat 1969, p. 277)

In India, N. C. Majumdar and his Defence Science colleagues have evaluated the WBGT, recognizing it as the only index developed for outdoor field use and formulated to take into account a high solar heat load. However, they have faulted the index by reason of (1) an erroneous assumption of equivalence of the wet bulb response to wind speed with the actual response of the human body; and (2) the constant weight of 70% given to the wet bulb temperature through the entire range of dry and humid hot environments, whereas experience shows that its weight should be relatively higher as its value increases. As a more accurate and scientifically-based measurement of outdoor hot environments, involving varying wind speeds and solar radiation, the Indian team devised a "Modified Effective Temperature" (MET) index. This is essentially based on the ET scale, after the outdoor conditions have been translated into an equivalent indoor environment with the help of two corrections: (1) a nomogram for evaluation of air temperature corrected for solar radiation in relation to color of clothing (or complexion of skin for nude subjects); and (2) a "correction to wet bulb in relation to dry bulb correction for radiation and observed wet-bulb temperature" (Majumdar and Bardhan 1966, p. 38). However, the index obviously tends to cumbersomeness in actual application.

Finally, although it is an admittedly non-radiant index, unsuitable for outdoor use, the so-called "Oxford Index" or WD (derived from "wet bulb-dry bulb") has proved to be both simpler than and somewhat superior to the WBGT in predicting physiological strain over a range of hot humid environments (Iampietro and Goldman 1965; Goldman, Green, and Iampietro 1965). It was first used by Lind (1963a, 1963b), and is based on the formula:

$$WD = 0.15\ T_d + 0.85\ T_w$$ [1]

2. Physiological Indices

As implied above (p. 409n), most physiologists today have concluded that sweat rate is a good measure of heat stress, but not of heat strain, on the individual, whereas the body temperature is a good measure of heat strain, but not of heat stress (Löfstedt 1966, p. 52). However, there have been a number of notable efforts over the years to formulate a heat stress index based essentially on observed physiological effects of heat. One of the

[1] Interestingly, the 85:15 formula is appropriate to humankind, but there appear to be significant intra-specific differences. Thus, for young pigs a 65:35 or, more probably, a 75:25 wet bulb-dry bulb weighting has been suggested (Roller and Goldman 1969).

earliest such attempts was that of Robinson, Turrell, and Gerking (1945). Their "Index of Physiological Effect" (Ep) was derived from the measured increases of heart rate, skin temperature, rectal temperature, and sweat rate of four acclimatized subjects working or resting in a laboratory at various temperatures and humidities, based upon a constant air movement of 180 fpm. Lines of equal physiological strain were plotted on charts, each chart representing a different metabolic rate. From this approach the authors were able to specify upper limits of heat tolerance, that is, the point beyond which, even in fit and acclimatized men at rest, thermal equilibrium cannot be maintained indefinitely and heat must necessarily accumulate in the body up to fatal heatstroke. The Ep lines follow a contour that is very similar to those of the Effective Temperature scale.

In terms of this scale, the physiological limit is a little more than Ep 200, or approximately 125° F. with a 20% relative humidity.[1] Military and industrial microclimates (in tank bows, or in deep mines, for example) may exceed this level and thus impose time limits on viable exposure. This amount of heat stress is probably never reached in open shade, free of radiation input, and for resting men, in any natural environment on the earth's surface. Even July average maximum temperatures in such places as Aden, Calcutta, and Algeria are only in the Ep 50-100 range (Molnar et al. 1946, p. 412). The Index of Physiological Effect is really suitable for application only to acclimatized persons, and it has been criticized on the ground that any one of the four physiological variables can reach a critical level independently of the others, without raising the combined index to the upper limit of tolerance.

In 1949 Blockley and Taylor proposed an index of physiological strain based on heart rate and skin temperature. However, this index was intended primarily to evaluate exposures of short duration (less than half an hour) to conditions of extreme heat (140° - 240° F.) (Blockley and Taylor 1949). This index was subsequently further refined for use in very hot, dry and still air (Blockley 1963).

The so-called Craig Index is a composite one of physiological strain, obtained by adding sweat production in kg/hr, the rise in rectal temperature

---

[1]This is approximately equivalent to 135° F. at 10% R. H., perhaps about 150° F. at zero humidity, but only 93° F. in completely saturated air.

in °C hr, and one-hundredth the heart rate at the end of a 30-minute period.[1] As Craig noted,

> This formulation provides a measure of heat stress free of a heat storage term depending on body temperature measurements, and so permits their use as an index of strain. (Craig 1950, p. 26)

But in a 60-subject, four-year study of tolerances to 59 different severe hot-wet climatic chamber conditions, the Craig Index (as well as the ET scale) gave a relatively poorer correlation with tolerance time than did the physical environmentally-derived indices, the WBGT and the WD, while the P4SR (see below) was intermediate in this respect (Goldman, Green, and Iampietro 1965).

In 1955 Belding and Hatch devised an "index for evaluating heat stress", later referred to as the HSI (Heat Stress Index), for special application to hot industries. Their index utilizes the principles of partitional calorimetry:

> Simple to use, it comprises a series of five charts to assess the heat exchange from convection, radiation, evaporation and metabolism, presenting the final assessment on a numerical scale. The scale is based on a comparison of the amount of sweat that has to be evaporated ($E_{required}$) to maintain thermal equilibrium and the maximum amount of sweat evaporation that can occur in the given conditions ($E_{maximum}$). (Lind 1964a, p. 173)

Belding and Hatch assumed a completely wetted skin with a skin temperature of 95° F. and subject to an upper limit of sweat production of one liter per hour, or 2400 BTU/hr (604.8 kcal/hr). Since clothing can greatly influence the heat exchanges, and since skin temperature does not remain at 95° F. under all conditions, attempts to modify the original formulation of this index have continued to the present time.

---

[1]Now it is recognized that the Craig Index (which, incidentally, Craig originally called the "Circulatory Strain Index") should be modified to take into account starting as well as final heart rates, and the varying effects of different rates of increments of pulse rate (Leithead 1968, p. 652).

The Belding-Hatch Heat Stress Index, consisting of a scale from 0 (no thermal strain) to 100 (intolerable heat) is necessarily standardized on fit, acclimatized young men and in terms of "maximum strain tolerated for 8 hours daily". Thus, in the 70 - 99 ("very severe heat strain") level of this index, efficiency in motor and intellectual performance is greatly impaired, energy expenditure must be limited, and other conditions (salt and water intake, intercurrent health status, etc.) must be optimal in order for the individual to function. For all but a very small percentage of those who are not fit, not young, or unacclimatized, the tolerance limit may be in the neighborhood of 70 rather than 100. At the level of moderately severe heat strain (40 to 60 on the Belding-Hatch index), there is some decrement in the performance of physical work, and in sustained mental work. This level of heat stress is well tolerated by the young, fit, and acclimatized group, but involves a threat to the health of those not so described. In conditions of moderately low heat strain (10 to 30), even heavy physical work can be carried out without decrement, although some impairment of psychological performance (intellectual functions, dexterity, alertness, etc.) may occur among all subjects.

Perhaps the best-known physiologically based index of heat stress is an empirical one derived from sweat rate alone--McArdle's P4SR or "Predicted Four-hour Sweat Rate" (McArdle et al. 1947). This was developed at the National Hospital in London in order to try to overcome difficulties in applying an Effective Temperature scale. According to the P4SR method, the amount of sweat secreted by fit, acclimatized young men when exposed to the given environment for four hours is taken as an accurate index of the heat stress of that environment. It is expressed through an empirically-derived nomogram. Some further refinement has been found necessary by incorporating rectal temperature readings in cases where the observed sweat loss appeared to differ significantly from the actual heat stress as judged by environmental factors. The P4SR scale has proved experimentally to be an accurate method of estimating heat stress over a considerable range of hot temperatures and in conjunction with large variations in energy expenditure, clothing worn, and the environmental factors. Its main limitations are that it tends to be less accurate in low humidity (Leithead 1967, p. 740), it is not very suitable for outdoor use--or at least for conditions of exposure to sunlight--and that it fails as an indicator at an upper limit of 130° F. air temperature, 98° F. wet bulb temperature, and 500 fpm air speed. Moreover,

> The index is complicated to use, the penalty for including all the factors of great importance in assessing heat stress. (Lind 1964a, p. 173)

The most telling criticisms of the P4SR, insofar as it may be intended for predicting actual physiological reactions rather than relative heat stress, have been made by Wyndham, who insists that unique regression lines must be fitted to each population under investigation (Wyndham 1962, p. 535). This is because the P4SR is based on sweat rate, which varies from person to person, and is subject to both saturation and exhaustion phenomena. In severe heat stress it may actually decline while rectal temperature and heart rate are rising. Wyndham and his colleagues especially note that there may be racial variations, Europeans sweating up to three times as much as non-Europeans at very high temperature levels, although the surface areas are only 10% greater (Wyndham et al. 1963, p. 232).[1]

As an undeservedly brief digression here, it may be noted that sexual and racial differences in sweat gland number, density, distribution, type, and activity have long been alleged (see, for example, Charters 1951, p. 176; Kuno 1956, pp. 46ff; Lind 1964a, p. 175). But at the same time, it now appears that individual variations within any given ethnic group are greater than overall differences between groups, and some carefully conducted studies indicate no significant racial differences, at least in total sweat gland numbers and output (Thomson 1954, p.   ; Barnicot 1959, p. 116).[2] The average man or woman is believed to have about 2,000,000 sweat glands, but most questions of their nature and functioning are surrounded by controversy. Thus, most experts believe that

> . . . all the sweat glands found in an adult are thought to be present at birth . . . (McCance, Rutishauser, and Knight 1968, p. 665)

But a partially conflicting view is also present, as the following quotations imply:

---

[1]In another recent study in Uganda, sweat production of Caucasian adult males was also found to be "much greater" than that of all other groups studied (Caucasian children and adult females, and Bantu men, women, and children), based on equal conditions of health, work rate, environment, etc. (McCance, Rutishauser, and Knight 1968).

[2]For India, I am not aware of published data in regard to individual or group differences in sweat glands, but research was being conducted on this very question in October 1966 by an anthropologist at the Defence Institute of Physiology and Allied Sciences.

> Children living in hot climates develop more effective and a greater number of sweat glands than their northern counterparts. (Burch and DePasquale 1962, p. 6)

> It might be thought, and has in fact been asserted, that some tropical peoples possess more sweat glands per unit area than Europeans and that this may be an advantage in evaporative cooling. (Barnicot 1959, p. 116)

It is known that women have a greater number of sweat glands per unit area also; this may be merely a function of body size. Kuno's classic and authoritative work serves as a good introduction to the complexity of human sweat gland types and activities. Dr. R. W. Newman of USARIEM is presently surveying the whole question of human physiological adaptation to extreme climates, and he believes that the types, size, total number, density, and distribution of sweat glands, seen merely as physical anatomical organs, are essentially rather meaningless, so far as efficient evaporative thermoregulation is concerned. What is important is the number of sweat glands actively functioning, their output, their threshold, and their endurance to fatigue (Newman 1971). In particular, the even distribution of the perspiration over the whole body is an essential requirement, and marked improvement in this respect is one of the changes which importantly occurs as a result of heat acclimatization (Folk 1966, p. 153). Overly profuse but poorly distributed sweating may in fact constitute a health threat to the unacclimatized.

The name of D. H. K. Lee has for many years been associated with efforts to develop a synthetic index of thermal strain. An early version was called the "Thermal Strain Index", and with subsequent improvements (Lee and Henschel 1963, 1966), the name became "Index of Relative Strain", and finally "Relative Strain Index". The index is based partly on heat transfer mechanisms and partly on specific observations of physiological reactions to increasing heat loads. Lee and Henschel's equation, formulated on the basis of combinations of air temperature and humidity, with appropriate additions or subtractions resulting from nonstandard conditions of air velocity, radiant heat, work, and clothing, aims to give a plotted line that closely fits that deriving from physiological observations of heat strain. (Lee has noted that the line of equal physiological strain plotted on a psychrometric chart characteristically runs parallel to the dry bulb temperature at lower levels, but then curves to run parallel to wet bulb temperature at high heat levels, demonstrating the prime importance of evaporative thermoregulation). However, Lee and Henschel's index has as yet been little utilized by others in the field, and it suffers from a dearth of experimentally confirmed correspondence with physiological data.

Recently Hatch has proposed a "Circulatory Index" or CI as a very good single physiological index of heat strain. He justifies this on the physiological grounds that overtaxing of the circulatory system, especially the diversion of blood from critical internal organs to the skin, is "the principal cause of physiological strain in response to heat stress" (Hatch 1963, p. 311). Thus, his index is expressed as:

$$\frac{1}{CI} = \frac{1}{B} + \frac{1}{K_s}\text{, where}$$

B = rate of cutaneous blood flow, in heat transfer units;
K_s = heat conductance through the skin, whole body; and
CI = over-all body heat transfer coefficient, or Circulatory Index

In effect, this is a ratio of cutaneous flow to cardiac output, a relationship considered more primary than such derived changes as cardiac output alone, heart rate, blood pressure, etc. Hatch further favors this index by reason of its meeting several other strict criteria: close fit with actual experience; conformity to "rational" biophysical stress-strain relationships; and its careful separation of stress parameters from strain parameters, the grounds on which McArdle's P4SR has been criticized.

For the industrial environmental physiologist primarily concerned with the capacity of any heat stress index to predict physiological strain with accuracy, the situation still appears to be unsatisfactory. As Wenzel (1965) and Kraning *et al*. (1966) have shown,

> No two combinations of metabolic and exogenous heat loads elicit the same combination of heart rate, rectal temperature, sweat loss and cardiac output. (Leithead 1968, p. 653)

3. Heat Exchange Indices and Coefficients

In view of the complexities of the environmental factors, and even more so of the human physiological responses to them, which together make up the measures of heat stress and heat strain, it is not surprising that considerable scientific interest has gone in the reductive direction of considering

> . . . man in relation to his heat exchange with his environment, which can be determined from established physical laws and can be expressed in quantitative terms. (Macpherson 1958, p. 36)

This is essentially the approach of biophysics, and the resultant indices or coefficients are sometimes classified as "rational", a description that might seem implicitly derogatory of those indices derived from the more refractory environmental and psychophysiological realities.

The best known early approach of this kind was that of workers at the J. B. Pierce Laboratory. In 1937 Winslow, Herrington, and Gagge formulated the idea of "Operative Temperature", based upon a quantitative evaluation of the various physical factors entering into the thermal equilibrium between a man and the environment, without any reference to subjective sensation.[1] Temperature, radiation, convection, and wind speed were included, but humidity was not considered. Operative temperature was defined as:

$$T_o = \frac{kr(tr) + kc(ta)}{kr + kc} ,$$

where tr and ta are the radiant wall and air temperatures (in °C), respectively, and kr and kc are constants for radiation and convection, respectively. A constant air movement of 17 fpm was assumed. Gagge later took the lead in refining the operative temperature formula to

---

[1]This index is somewhat similar to Bedford's "Equivalent Temperature" (p. 415 above), which was used extensively by ventilating engineers, and was formulated: Equivalent Temperature = $0.522\ t_a + 0.478\ t_w - 0.0474\ v(100 - t_a)$, where t_a = air temperature, t_w = mean radiant (or "wall") temperature, and v = air velocity.

take account of a range of air movement, producing a lengthy equation which would provide a figure to be known as "Standard Operative Temperature, said to be based on Newton's Law of Cooling and first defined as

> . . . the equivalent environmental temperature with which a warm body (such as a human or animal subject) with surface temperature, t_s, exchanges heat at a <u>standard</u> cooling rate (excluding evaporation effects). (Gagge 1940, p. 103)

In recent years a more polished phrase has replaced this, one that goes something like:

> . . . the uniform temperature within an imaginary "black" enclosure in which man, with an average skin temperature, would exchange the same dry heat as he would in the actual complex environment. (Gagge 1970, n.p.)

Unfortunately, as Gorosomov (1958, p. 6) has pointed out, operative temperature requires obtaining of the skin temperature, and thus cannot be derived from ordinary meteorological data.

The previously-described Heat Stress Index of Belding and Hatch of course falls in the general line of descent of "rational" or biophysically-oriented heat stress indices, as do the earlier "Ft. Knox Heat Exchange Coefficients" of Nelson <u>et</u> <u>al</u>. (1947). These latter were extended in 1952 by Haines and Hatch to write their heat balance equations for a man at work, describing the coefficients of heat exchange between man and his environment by radiation, convection, and evaporation (Haines and Hatch 1962).

Mention may also be made of an early approach along these lines by Ionides, Plummer, and Siple (1945), who worked with the notion of a "Thermal Acceptance Ratio",

> . . . defined as the rate at which the environment in question is capable of accepting heat from an unclothed person if his skin temperature is maintained at an assumed safe limit of 97° F. and <u>M</u> is the rate of heat production in the body. (Macpherson 1962, p. 156)

This index suffered somewhat from the same inexactitude in assuming skin temperature in relationship to heat tolerance that has troubled other such approaches.

Despite the higher level of scientific purity implied by their hewing to strictly quantitative calculations of heat exchange, some at least among the biophysicists display a proper modesty with regard to their cognizance:

> It is not advisable to use the physical theory to predict human physiological reactions where direct physiological experiments can be substituted. However, it can be used to make qualitative estimates where physiological data are not yet available. (Woodcock, Powers, and Breckenridge 1956, p. 14)

Many hitherto imprecise areas in the nature and measurement of thermal stress are gradually being quantified by workers at the J. B. Pierce Laboratory,[1] e.g., a recent study seeking to express mathematically the basis of subjective response to changes in operative temperature from the neutral zone to cold discomfort and heat discomfort, and which concludes:

> . . . discomfort caused by cooling grows as the 1.7 power of shifts downward in temperature from the level that feels comfortable; discomfort caused by heating grows as the 0.7 power of shifts upward from the level that feels comfortable. (Stevens, Marks, and Gagge 1969, p. 149)

In recent years, too, considerable work has been done by individuals seeking to improve and refine the essential heat exchange and thermal equilibrium ratios arrived at by Belding and Hatch in 1955, since

---

[1]See the following source, just published:
John B. Pierce Laboratory (New Haven, Conn.) 1970. Proceedings, Symposium on Physiological and Behavioral Temperature Regulation, 19-23 August 1968. 24th International Congress of Physiological Sciences. Springfield, Illinois: C. C. Thomas

> The original graph type charts for determining HSI . . . are no longer applicable since improved coefficients and exponents are now utilized in the equations for estimating the radiation and convection loads and the maximum cooling resulting from the evaporation of perspiration. (McKarns and Brief 1966, p. 14)

Foremost among the recent approaches are Hatch's "Improved Heat Exchange Coefficients" (Hatch 1963), the HSI2 or Heat Stress Index updated by Hertig and Belding in 1963, Lustinec's "Heat Strain Predictive System" (Lustinec 1965), McKarns and Brief's nomographs incorporating new coefficients for the HSI (McKarns and Brief 1966), Sibbons' "Equivalent Operative Ambient Temperature" (Sibbons 1966), and a new standard for thermal comfort developed by Nevins et al. (1966).

Experts in this field also admire Givoni's "Index of Thermal Stress" (Givoni 1962, 1963), based on the sweat rate required for maintenance of thermal balance, and which takes into account the actual cooling efficiency of the sweat produced. It is said to fit not only his own experimental data, obtained under greatly varying climatic conditions, but also the published data of many other investigators (Givoni and Sohar 1968, p. 41). However, Leithead notes that

> . . . it was developed in Israel in outdoor conditions of high solar radiation and still requires examination in indoor long-wave radiant heat. (Leithead 1967, p. 741)

Another recent development of the HSI is a 12-stage operation leading through heat balance equations and the coefficients proposed in Givoni's ITS to a prediction of the limits of human exposure to a given condition (Vogt and Metz 1966). This is based on a maximal permissible rise of 1.2 C.° (2.16 F.°) in body core temperature.

Biophysicists at the U. S. Army Research Institute of Environmental Medicine in Natick, Mass. have recently described a method, utilizing three globe thermometers, enabling them to measure completely the purely thermal environment, while seemingly ignoring the subjective aspects (Woodcock and Breckenridge 1965). These workers have been in the forefront of recent research involving the thermal effects of clothing, especially the various specialized and protective clothing used in military activities. Clothing acts essentially as a heat-insulating and moisture-impeding barrier. Biophysicists first gave the name "clo" to a unit of heat-insulative body covering in 1941:

> One clo approximately is the value of the insulation of one's everyday clothing (and incidentally of a heavy top coat alone). (Gagge, Burton, and Bazett 1941, p. 429)

> One clo has been defined as the insulation necessary to maintain in comfort a sitting, resting subject in a normally ventilated room (air movement 20 feet per minute at a temperature of 70° F. and a humidity of the air less than 50 percent . . . (Belding et al. 1945, p. 13)

At ground level, with no wind, the still air envelope which surrounds human skin has an insulative value of about 0.8 clo. It is about 0.6 clo at 1 mph (or 88 fpm), 0.4 clo at 2 mph, 0.3 clo at 5 mph, and 0.2 clo at 10 mph.[1] Therefore, the equation which is ultimately derived for calculating total clo value or insulation (I) is a combined effect of the I_{cl} or thermal insulation of the clothing and the I_a or insulation of the ambient air. The essential formula for relating heat loss from the skin to the environment through dry clothing is

$$H_d = \frac{T_s - T_a}{I \text{ (or } I_{cl} + I_a)} ,$$

where H_d = rate of dry heat loss per unit area, T_s = skin temperature, T_a = ambient temperature, and I = insulation, or the clo factor (Woodcock 1962, p. 629).

---

[1]These are figures reported by Belding et al. According to a very recent source (Fourt and Hollies 1970, p. 34), still air provides a clo value of 0.85, while the other equivalents are: 0.7 clo at 50 fpm, 0.5 clo at 120 fpm, 0.3 clo at 425 fpm, and 0.1 clo at 4500 fpm.

The clo or insulative value of clothing is primarily relevant to cold environments, not to heat stress.[1] It is the permeability or evaporative impedance of clothing which is important in hot environments, and in 1962 Woodcock published formulas for the calculation of a "permeability index" (i_m), opening for the first time the possibility of a quantification of the physiological effects of clothing in hot environments as well as in cold, and allowing

> . . . a pair of parameters [clo and i_m] to describe the effect of clothing through a unified concept that is the same whether the environment is hot, cold, or temperate. (Woodcock 1962, p. 632)

Advances in the theoretical synthesis of the two factors of insulation and evaporative transfer properties of fabrics have been recently discussed by Goldman (1967).

One of the most comprehensive of recent efforts to compare experimentally several of the heat transfer coefficients or "rational" heat indices, applying them against 29 specific physiological parameters (sweat rate, conductance, heart rate, oxygen consumption rate, modified tension-time index per minute, diastolic blood pressure, rectal temperature, duration of systole, respiratory frequency, and so forth), has just been reported by Peterson (1970). He found that some indices correlated better with some of the parameters, and some with others. Obversely,

> Sweat rate was the biothermal strain best correlated with all stress indices except the A_o [Sibbons' equivalent operative ambient temperature], and therefore sweat rate came closest of all physiological parameters to being an indicator of total strain. (Peterson 1970, pp. 316-317)

---

[1]Physiologists may also speak of the insulative values of body tissue in terms of clo. According to Goldman (1971), these range from 0.2 with full vasodilatation to 0.8 when fully vasoconstricted. The greater insulation provided by extra layers of fat of course has the effect of reducing body cooling by heat transfer in the case of obese individuals, who are consequently better protected against cold, but also less effective in achieving cooling in the heat. In regard to body surface heat loss, ". . . the local insulation provided by 1 cm. of subcutaneous fat is rarely likely to exceed 0.8 clo" (Bazett 1949, p. 145).

Peterson's general conclusion simply reflects the caution already amply cited at the beginning of this chapter:

> These findings support the idea that to completely analyze the effect of heat stress on man several different stress indices may be necessary, each with its own area of precision. (Peterson 1970, p. 314)

But Fox believes the multiplicity of heat stress indices is already so great as to negate the value of any new one, unless it is extremely precise and comprehensive. Yet he grants that

> . . . the use of electronic computers for analysing results could afford one great advantage not available in the earlier studies. (Fox 1965, p. 64)

4. Evaluation of Indices

In summary, it appears that each of the indices described above has a distinctive usefulness in relation to some specific range of environmental conditions, and in situations varying according to characteristics or requirements of subjects and observers. But no single index is the best for measuring mild as well as extreme heat stress, or for use outdoors in a desert as well as in a deep mine or in the hold of a ship, or in strong variable winds as well as in still air, or where the work rate is and where it is not known. The effects of clothing, of energy expenditure, and of acclimatization status are critical, but no index can include all of them without becoming too unwieldy for practical use.[1] It is difficult to summarize these indices better than has been done by Fox:

> The three most important are the Effective Temperature scales, the Heat Stress index and the P4SR index. Effective Temperature remains the best way of comparing and describing conditions at mild levels of heat stress and in the comfort zone; the Heat Stress index is valuable at higher levels of heat, because it enables the situation to be analysed so that the most appropriate remedy can be

---

[1]Much of the difficulty probably derives from the rather discontinuous effect of humidity on heat stress. In this connection, Kerslake has proposed the concept of "critical humidity" (without, however, explaining how this can be arrived at), below which variations in humidity have only small effects on heat stress, and above which their influence is very large (Kerslake 1958, p. 68).

chosen; the P4SR index affords the most accurate way of relating heat stress and physiological strain.

By virtue of its simplicity the W.B.G.T. index also fills a useful place, but whenever possible an index giving a more accurate and complete description should be used. (Fox 1965, p. 63)

Many physiologists are now using an "engineering" approach and are developing models of the thermoregulatory system which should serve to predict responses to heat stress in various environments. The chapter on "Physiological Principles, Comfort and Health" (provisional title), which will appear in the next revision of the ASHRAE Guide on Fundamentals (in press) will constitute the most up-to-date review of the whole subject.

B. Levels of Heat Tolerance

It is possible to define three different limits of heat strain, or three different thresholds of heat tolerance. In ascending order of severity they mark the limits of comfort, efficiency, and survival. In the first case, we are interested in the threshold of change from thermal neutrality to a sensation of heat discomfort. For any given individual at any given time there is a zone of thermal comfort or neutrality, the center of which may be taken as the optimal point. Although Macpherson states flatly that "Individuals otherwise indistinguishable vary widely in their capacity to withstand the effects of heat" (Macpherson 1958, p. 39), little research has been done on the nature and basis of these individual variations.[1] Not only this, but also the thermal optimum is different at different times for the same individual. Leaving aside violent changes resulting from fever or other abnormalities, we may thus recognize normal nycthemeral, seasonal, and other cyclical fluctuations up and down--not only of the thermal optimum and the whole neutral zone, but perhaps also of the width of the band of thermal neutrality.

In this area of heat stress, the zone of mere "discomfort", subtle psychological and cultural factors are likely to play a considerable role. So far as precise measurement is concerned, the monitoring of physiological responses may not even serve to confirm findings based on subjective

[1]See pp. 318-324 above

sensations expressed through comfort votes by subjects, particularly unless the state of acclimatization is held constant. The optimum temperature for temperate-zone residents is several degrees lower in winter than in summer, it is lower in cold regions than in the tropics, and it is lower for the unacclimatized visitor to the tropics than it is a few weeks later after he is acclimatized. Despite the well-taken criticisms of the effective temperature scale, it remains, in one or another of its improved forms, the most widely used index for describing thermal comfort and discomfort in specific environments below the level of pronounced physiological strain.

In view of the importance of physiological acclimatization in relation to responses to heat, a few words are overdue on this matter, which has been described by Bass (1963), Ladell (1964), Lind (1964a), and many other physiologists, and has been expertly reviewed by Fox (1965). Briefly, heat acclimatization consists of a series of physiological adjustments which take place in individuals exposed to a hot climate (and especially if they are working rather than merely sitting or resting), allowing them to maintain equilibrium at a higher environmental temperature than was the case before acclimatization. Fox summarizes the classic picture of acclimatization to heat:

> The main features are a less marked increase in the heart rate while working, lower skin and deep body temperatures, a greater production of sweat and, subjectively, a lessened sense of discomfort. (Fox 1965, p. 66)

German workers have recently concluded that the really critical element in heat acclimatization is the increased sweat production which permits a <u>fully</u> (evenly-distributed) wetted skin, and thus sufficient evaporation. In the unacclimatized, the skin is not wetted over its entire surface, and sufficient evaporation can only be reached by an increase in body (skin) temperature (Höfler, Ladipoh, and Laaser 1969).

The differential in temperature tolerance attributable to full acclimatization seems to be about 5 - 7 F.° ET (for unclothed men). The length of exposure time to attain full heat acclimatization has long been held to be about three weeks. But the first week of this process is quite rapid, making up 80% of the total, according to Robinson <u>et al</u>. (1943, p. 176). And for practical purposes, stress physiologists today produce an acceptable level of heat acclimatization in four days (Leithead 1968, p. 653; Goldman 1971). The circulatory improvements characteristic of heat acclimatization are completed more rapidly than the changes in sweating (Ladell 1964, p. 627). But all of these figures related to heat acclimatization are probably subject to considerable variation, and side by side with the optimistic physiological estimates of quick acclimatization are to be noted the reservations of others (see p. 322 above) that subtler but important aspects of heat acclimatization may require weeks or even months to develop. There is the additional question, not yet well answered, as to the extent to which exposure and work in hot dry environments gives acclimatization to hot humid conditions, and vice versa.

In fact, the evidence surrounding the physiological dynamics of acclimatization is as conflicting, or so it seems to the layman, as it is prolific. As one example, most authorities are convinced that acclimatization produces an increase in sweat output (Bass 1963, p. 302; Lind 1964a, p. 19), but Belding claims that men do not usually sweat more after acclimatization, that only the threshold of onset is lowered (Belding 1962, p. 1053). And whether, or to what extent, blood volume increases during heat acclimatization is still debated (Ladell 1965, p. 251). Again, Johnson found that South African gold miners lose their heat acclimatization after only 6 days (Johnson 1965), while other experimental studies have shown heat acclimatization to be retained for 8 days (Lind and Bass 1963, p. 708), two weeks (Bass 1963, p. 300), or 3 weeks (Henschel, Taylor, and Keys 1943, p. 325).[1] Scientific views of acclimatization range from those seeing it as a rather profound organic transformation to those looking upon it as

> . . . largely, though by no means entirely, a process of habituation, whereby the stimuli of an accustomed environment produce a lesser response (and incidentally fewer sensations) than a new environment. (Glaser 1963, p. 139)[2]

Finally, there is large conflict of evidence as to possible metabolic adaptations, such as a lowered basal metabolic rate, in heat acclimatization (Fox 1965, p. 74). Lower BMR's are usually found in long-time

---

[1]And one report has it that ". . . some men retain a fair degree [of heat acclimatization] at the end of 2 months" (Machle and Hatch 1947, p. 220).

[2]See also Glaser 1966.

residents of the tropics, and Fox has provided an especially clear analysis of the problem of possible differences between "artificial acclimatization" (in hot chambers, and on which so much of the experimental literature is based) and "natural acclimatization". As he notes, only scanty knowledge has been gleaned to date on the physiological adjustments of indigenous populations of hot places (Fox 1965, p. 75). In one of the few studies designed to partly illuminate this question, Edholm et al. (1963) showed that soldiers can without question be brought quickly by means of heat chambers in a cold climate to a level of heat fitness that in all physiological respects equals that of naturally-acclimatized troops. And still, when their actual efficiency of performance of duties is examined, the naturally-acclimatized men proved to be much superior. As a partial explanation, the latter probably know

> . . . how to do things and live in a particular hot climate with the minimum of strain. (Edholm et al. 1963, p. 715)

To return to the three levels of heat tolerance, beyond discomfort the next threshold of heat strain is that of efficiency impairment--however that may be defined, since various kinds of performance decrements occur at different levels of stress.[1] For fit and acclimatized young men, a number of authorities have found an ET of 86° F. to be the approximate threshold of impaired psychomotor performance (Pepler 1963, p. 334; Goldman 1968), but accuracy in the performance of mental tests among the same kind of population declines even at 83 ET (Crowden 1949, p. 332). Lind has recently sought to clarify the meaning of the phrase "heat tolerance", which has become very confused in usage (Lind 1963c). He has thus distinguished three kinds of conditions of heat exposure: (1) intolerable; (2) just (intermittently) tolerable; and (3) easily (continuously) tolerable. Lind is emphatic that work rate needs to be clearly specified in setting limits or guidelines in terms of Effective Temperature or P4SR, and he concludes that for continuous work at 100 kcal/m^2/hr, 167 kcal/m^2/hr, and 233 kcal/m^2/hr (approximately equivalent to walking at 2 mph, 3.5 mph, and 4.5 mph, respectively, a range that covers most industrial activities), the corresponding ET values are about 86, 82, and 80 (°F.) for "easily (continuously) tolerable conditions"--that is, up to 8 hours daily, and of

[1]See Pepler's recent survey articles (Pepler 1963, 1964). A large body of literature exists seeking to quantify "safe exposure times", arising mostly out of industrial health concerns. See especially Bell, Walters, and Watts (1969), and the bibliography included therein.

course accompanied by profuse perspiration. Both Haffernon, Hittner, and Kocis (1953) and Buskirk (1970) have used the term "critical ET" to refer, respectively, to the point at which large numbers of men in military training will develop heat exhaustion, and the point at which body heat stores begin to increase at a rapid rate. The former place this figure at 85 for fully heat-acclimatized men, but an ET of 83 or even lower for unacclimatized soldiers. At 92.5 ET the average person will have a rise in body temperature of 1.7 F.° and an increase in pulse rate of 48 per minute in 3 hours (Ferderber and Houghten 1941, p. 477). An ET of 96.5 is equal to 131° F. dry bulb temperature with 20% relative humidity, or 99° F. with 90% R. H. (Ibid., p. 477). Napier assumed that this is about the upper limit of tolerance of the body, even naked and at rest (Napier 1943, p. 36). But sensations of heat (on which ET scales are based) become increasingly unreliable with higher levels of heat stress, and the experiment of Sen in India (see below) indicates that the critical figure expressed in terms of ET may be quite variable, depending on vapor pressure (Sen 1966). Here in the zone where sweat evaporation is all-important, a physiologically-based index such as the P4SR or the HSI of Belding and Hatch proves to be more accurate. The latter is more useful in indicating the main avenues of stress, and in fact a recent opinion (Goldman 1971) is that within 10 years or so most physiologists will have abandoned the P4SR, despite the excellent opinion that has been expressed of it:

> The predicted 4-hourly sweat rate (P4SR) index is the most accurate of the existing indices of heat stress (Lind 1964a, p. 172)

It would be interesting to look at the heat stress indices from the other side of the mirror, as it were. That is, one might begin with two environments, one hot-dry and the other hot-humid, which in actual laboratory test are found to produce about the same work-time tolerances, and then compare both the environmental parameters and the physiological effects. Sen has done something like this in India, although the different levels of energy expenditure which occurred in the two environments unfortunately vitiate any real comparability between hot-dry and hot-wet conditions. Still, the results are worth noting for their display of the large discrepancies that can occur:

Environmental/physiological Conditions/effects	Hot-dry	Hot-humid[1]
Tolerance time (estimate)	90 min.	80 min.
Dry bulb temperature	109° F.	99° F.
Wet bulb temperature	89° F.	92.5° F.
Mean surrounding (wall) temperature	260° F.	101.3° F.
Corrected Effective Temperature (CET)	97.2° F.	92.5° F.
P4SR	9.15 liters	2.32 liters
Belding-Hatch Heat Stress Index (HSI	77	148
Oxford Index (WD)	91.7° F.	93.5° F.
WBGT	101.0° F.	94.6° F.
Pulse rate	188	130
Blood pressure	160 110	125 85
Energy expenditure (kcal/m^2/hr)	202.8	137.7

It is, of course, no surprise to heat stress physiologists that

> . . . at the same level of physiological strain, hot-wet and hot-dry environments do not necessarily correspond to the same level of a particular heat stress index. (Renbourn 1965, p. 5)

Most of them further conclude, along with Renbourn, that

> . . . at the same apparent level of heat stress, more physiological strain is found in a hot-humid than in a hot-dry environment. (Ibid., p. 5)

It will be recalled that the Belding-Hatch HSI is stated in terms of maximum tolerable daily heat strain. Heat strain over the 100 level of this index (and well below it in the cases of those who are not acclimatized and fit) is thus by definition not tolerable for more than 8 hours a day. However, a given environmental condition that produces an HSI strain over

---

[1]From Sen 1966, p. 78

100 (and hence produces an unacceptable net buildup of heat in the body when maintained for more than 8 hours daily) can be tolerated for a shorter period of time, or even for a full 8 hours if a higher skin temperature than that assumed can be maintained. Thus, at the most severe level of heat strain, where the third and last threshold is death (through an irreversible heatstroke, or cardiac arrest, or the like), physiologists are most likely to speak in terms of tolerance times (in hours or in minutes) before collapse. These may be based on biophysical calculations of net rate of heat gain,[1] but may also be predicted by an index such as the WD, the WBGT, or the P4SR. Of course, laboratory experiments do not allow subjects to reach the survival frontier, although they may reach the point of initial collapse.[2] Consolidated psychrometric plottings of the various levels of discomfort, physiological impairment, and physiological breakdown are provided by Lee (1964, pp. 26-27), among others.

If one is interested in knowing the tolerance capacities of man in absolutely dry air--a condition which never occurs in nature although it may be approximated in some deserts--a number of studies are summarized by Folk (1966, pp. 151-152). In Blockley's hot-chamber studies, 8 subjects dressed in "a standard one-piece underwear garment and the equivalent on the hands and feet" tolerated 160° F. for 60 minutes, 200° F. for 40 minutes, and 235° F. for approximately 20 minutes (Blockley 1963). Webb, from similar studies, came to about the same conclusions, but asserted that 250° F. can be tolerated by a clothed man for only 20 minutes at most (Webb 1963, p. 250). Nevertheless, in another recent study 7 men remained

---

[1]In a manner somewhat similar to that of the French workers (Vogt and Metz), the nomographs of McKarns and Brief aim to establish with some precision the allowable exposure times (essentially limited by a 2 F.° rise in body temperature) to any of a variety of hot environments, as well as the minimum recovery time in a cooler rest location required to achieve a normal body temperature (McKarns and Brief 1966, p. 114).

[2]Fatal heatstroke has been produced and studied experimentally in animals such as dogs and rats (Daily and Harrison 1948). Possibly, inhumane experiments along this line may have been perpetrated in Nazi concentration camps, for it is known that a number of helpless prisoners died at Dachau after being immersed in ice cold water with a view to evaluating different methods of treating air crewmen forced down in the North Sea (see Alexander 1945).

at 400° F. for 20 minutes, sustaining a rise in mean skin temperature to 109.4° F. and a rise of 1.6 F.° in rectal temperature (Murray and Ross 1965). Tolerance time in these studies is, of course, limited by body heat storage.

At higher temperatures and for shorter periods, tolerance time is limited rather by skin pain. The skin temperature marking the threshold of intolerable pain is 113° F., and at 120° F. the irreversible tissue damage of a burn will develop in only a few seconds, but

> In dry, still air at 260° F. skin temperature does not reach this level, partly because air has a low specific heat . . .; partly because the latent heat of evaporation of sweat is highly effective in cooling the skin; and partly because the blood vessels in the skin dilate and heat is rapidly transported away from the hot skin into the body's cooler interior. (Fox 1965, p. 56)

Here the studies of Paul Webb appear to be definitive, and they generally conclude that at a heating level of 3000 kcal/m^2/hr, the tolerance time to pain on uncovered skin is 15 seconds, at 2000 kcal/m^2/hr it is 45 seconds, and at 1000 kcal/m^2/hr it is 3 minutes (Webb 1963, p. 250). The last figure is roughly equivalent to 350° F.

C. Problems of Chronic and Cumulative Heat Stress

Military and industrial requirements have largely shaped the kind of scientific inquiry and models that have just been discussed. But in relation to the main interests of the present study,

> The identification of conditions which are physically tolerable for fit young men for a brief period is . . . much less important than determining the conditions which are acceptable to a whole population for long periods of time. (Macpherson 1958, p. 38)

Experience shows that emotional limits of heat tolerance, which are much more difficult to measure than physical and mental limits, are nevertheless real and important. For one thing, a number of the body's mechanisms for compensating heat stress become fatigued with the passage of time. There is evidence that heat strain--when it is continuous and when it is accompanied by some of the numerous concurrent hardships so often faced by an inhabitant of the tropics--may in actual practice be intolerable at a much lower level than that implied by physiological laboratory or test-chamber studies.

Perhaps more than any other physiologist interested in the assessment of heat strain, Wyndham has addressed himself to the problems of comparing hot-dry and hot-humid climatic regimes, and has expressed the need to take into account the debilitating effects of sleeplessness, heat-caused skin disorders, etc. (Wyndham 1962, 1964). American experience during the building of Boulder (now Hoover) Dam dramatically corroborates the importance of these factors. During both summers (1931 and 1932) when construction was under way, the day shade temperature at the dam site reached 127.4° F., and there were several days when the temperature remained above 100.4° until after midnight. During the first summer, when no air conditioning was provided for night sleeping, there were 95 deaths from heat and hundreds of cases of heat cramps and heat exhaustion. The next summer, with air conditioned dormitories available, there were no deaths and only 5 cases of heat cramps (Dill 1938, pp. 88-89). Very similar results were noted among British army aviators operating in the extremely hot climate of southern Arabia (Perry 1967). Even with sleep in air conditioned quarters, it was observed that after the first year a decrease in efficiency began to exceed the gain in experience, tempers were shorter, and undue risks tended to be taken. Where air conditioned sleeping quarters were not available, it was found that more sleep was needed, 10 hours per night being an average requirement, and even this was not restful, giving a "washed out" feeling the next day (Ibid., p. 218).

Conventional mattresses are very unsuitable for tropical use, for over 50% of the body surface is made ineffective for heat loss by convection and radiation when sleeping on them. Thus, equivalent temperatures in still air can seem more oppressive at night than in the daytime. In fact, in his Australian studies Wyndham found that discomfort occurred at night at 76.5 ET, compared to an ET of 80 during the day, even though it might have been assumed that a lower rate of metabolism would tend to raise the upper limit of comfort rather than to lower it (Wyndham 1964, p. 193). This finding bears considerable significance for an understanding of comfort and good health in the tropics.

Recognizing that the records of maximum dry bulb temperature or even of effective temperature among various Australian stations did not closely enough reflect the relative heat discomfort and fatigue actually experienced by people in these stations, Wyndham prepared "discomfort frequency" summaries. Taking an ET of 78 as the critical level for skin disorders, and an ET of 83 as the threshold for initial decrease in performance, Wyndham counted the number of hours (per month or per annum) when these figures were exceeded during the night, based on three readings: at 2000 hours (when the evening meal produces increased metabolism), at 2400 (the time at which one must be free of irritations and stimuli in order to fall asleep), and at the early morning time of minimum temperature, whenever that might be. These comparative night temperature frequency figures gave a much closer approximation to the heat discomfort and heat illnesses actually reported in various Australian hot-dry and hot-humid stations than temperatures based on maximum daytime readings. In terms of Wyndham's figures, calculated in still air, dramatic decreases in discomfort frequency in hot humid conditions could be obtained by the provision of air movement by fans.

Another attempt to quantify the cumulative effect of heat stress is that of Thom, who has expended his DI (or THI) to a "Cumulative Discomfort Index" (CDI). Taking 24° C. (75.2° F.) as his critical point, he obtains a daily CDI figure computed from the total number of DI or THI units (in °C.) by which the level of 24° C. is exceeded during the total of 24 daily hourly readings. Israeli scientists have made considerable use of the CDI in assessing hot environments (Sohar and Adar 1964; Tennenbaum and Sohar 1960; Tennenbaum et al. 1961), and in one Israeli study a close correlation was found between CDI and Corrected Effective Temperature (Sohar, Tennenbaum, and Robinson 1962).

Despite the large number of climatological atlases showing standard meteorological statistics--average, minimum, and maximum temperatures, etc.--there is a surprising dearth of published efforts to map the thermal environment in terms of cumulative stresses, and especially giving sufficient weight to ambient night sleeping-quarter conditions. Of course, the necessary longtime meteorological data are generally lacking, but formulas for approximating the probable coincident temperatures, vapor pressures, wind speeds, and radiation for 24 hours might be developed. Among climatologists, noteworthy recent work has been done by Hounam (1967) and Terjung (1967, 1968).

Even from the standpoint of those seeking to predict the probable incidence of heat injuries from meteorological conditions on a more short-term basis, Macpherson finds the existing indices inadequate:

None of the indices of heat stress take into account the deleterious effect of cumulative stress due to heat lasting several days. It is certainly true that many more people can endure the effects of a heat wave of one day's duration than one of several days. . . . The ideal solution to this problem would be a psychrometric chart portraying a time axis. (Macpherson 1958, p. 190)

In the future, there will probably be developed numerous additional variants of the existing indices, each designed for maximally accurate interpretation of some particular situation or set of conditions.

LIST OF REFERENCES

American Society of Heating, Refrigerating, and Air-Conditioning Engineers. 1965. ASHRAE Guide and Data Book for 1965 and 1966. Fundamentals and Equipment. New York: ASHRAE

Angus, T. C. 1968. The Control of Indoor Climate. Oxford: Pergamon Press

Barnicot, N. A. 1959. "Climatic factors in the evolution of human populations", pp. 115-129 in Genetics and Twentieth Century Darwinism (Cold Spring Harbor Symposia on Quantitative Biology, Vol. XXIV). Cold Spring Harbor, L. I.: The Biological Laboratory

Bass, David E. 1963. "Thermoregulatory and circulatory adjustments during acclimatization to heat in man", pp. 299-305 in Temperature: Its Measurement and Control in Science and Industry, Vol. III, Part 3 (James D. Hardy, ed.). New York: Reinhold Publishing Corp.

Bazett, H. C. 1949. "The regulation of body temperatures", pp. 109-192 in Physiology of Heat Regulation and the Science of Clothing (L. H. Newburgh, ed.). Philadelphia and London: W. B. Saunders

Bedford, Thomas. 1936. The Warmth Factor in Comfort at Work. London: HMSO (Report of the Industrial Health Research Board, No. 76)

_____. 1946. Environmental Warmth and its Measurement. London: HMSO (Medical Research Council War Memo No. 17)

Belding, Harwood S. 1958. "Problems in developing a valid index of heat stress", pp. 40-49 in Proceedings of the Sixth International Congress on Tropical Medicine and Malariology, Lisbon, Sept. 5-13, 1958, Vol. VI

Belding, Harwood S. 1962. "Hazards to health: work in hot weather", The New England Journal of Medicine, Vol. 266, pp. 1052-1054

Belding, H. S., Darling, R. C., Griffin, D. R., Robinson, S., and Turrell, E. S. 1945. "Evaluation of thermal insulation provided by clothing", pp. 9-20 in Clothing Test Methods (L. H. Newburgh and Milton Harris, eds.). Washington, D. C.: National Research Council. Committee on Aviation Medicine (Report No. 390)

Belding, H. S. and Hatch, T. F. 1955. "Index for evaluating heat stress in forms of resulting physiological strains", Heating, Piping and Air Conditioning, Vol. 27, pp. 129-136

Bell, C. R., Walters, J. D., and Watts, Ann N. 1969. Safe Exposure Times for Men Working in Hot and Humid Conditions. Report presented to the Ninth Commonwealth Defence Conference on Clothing and General Stores, Kenya

Blagden, C. 1775. "Further experiments and observations in a heated room", Philosophical Transactions of the Royal Society of London, Vol. 65, pp. 484-494

Blockley, W. V. 1963. "Heat storage rate as a determinant of tolerance time and duration of unimpaired performance above 150° F.", Federation Proceedings, Vol. 22, pp. 887-890

Blockley, W. V. and Taylor, C. L. 1949. "Human tolerance limits for extreme heat", Heating, Piping and Air Conditioning, Vol. 21, pp. 111-116

Blum, H. F. 1945a. "The physiological effects of sunlight on man", Physiological Review, Vol. 25, pp. 483-530

_____. 1945b. "The solar heat load: its relationship to total heat load and its relative importance in the design of clothing", Journal of Clinical Investigation, Vol. 24, pp. 712-721

_____. 1964. "Effects of sunlight on the human body", pp. 229-256 in Medical Climatology (Sidney Licht, ed.). Baltimore: Waverley Press

Braun, David L. and McNall, P. E. Jr. 1969. "A radiometer for environmental applications", ASHRAE Transactions, Vol. 75, Part 1, pp. 235-245

Brazol, D. 1951. "La temperatura biológica óptima", Meteoros, Vol. 1, pp. 99-106

Brazol, D. 1954. "Bosquejo bioclimático de la República Argentina", Meteoros, Vol. 4, pp. 381-394

Burch, George E. and DePasquale, Nicholas P. 1962. Hot Climates, Man and his Heart. Springfield, Ill.: Charles C. Thomas

Buskirk, E. R. 1970. Metabolism and Exercise. Draft manuscript

Charters, A. D. 1951. "The effect of climate on the health of Europeans in the Kenya Highlands", East African Medical Journal, Vol. 28, pp. 174-188, 204-213

Conn, Jerome W. 1949. "The mechanism of acclimatization to heat", Advances in Internal Medicine, Vol. 3, pp. 373-393

Craig, F. N. 1950. "Relation between heat balance and physiological strain in walking men clad in a ventilated impermeable envelope", Federation Proceedings, Vol. 9, p. 26

Crowden, Guy P. 1949. "A survey of physiological studies of mental and physical work in hot and humid environments", Transactions of the Royal Society of Tropical Medicine and Hygiene, Vol. 42, pp. 325-340

Davies, W. R. 1963. Assessment of Thermal Conditions in H. M. Ships. London: HMSO (Medical Research Council. Royal Naval Personnel Research Committee. Report No. 63/1036)

Dill, David Bruce. 1938. Life, Heat, and Altitude. Cambridge: Harvard University Press

Dufton, A. F. 1932. The Equivalent Temperature of a Room and its Measurement. London: HMSO (Department of Scientific and Industrial Research, Building Research. Technical Paper No. 13)

_____. 1933a. "The use of the kata-thermometer for the measurement of equivalent temperature", Journal of Hygiene, Vol. 33, pp. 349-352

_____. 1933b. "The measurement of equivalent temperature", Journal of Hygiene, Vol. 33, pp. 474-475

Edholm, O. G., Fox, R. H., Adam, J. M., and Goldsmith, R. 1963. "Comparison of artificial and natural acclimatization", Federation Proceedings, Vol. 22, pp. 709-715

Ellis, F. P. 1962. "Some thoughts on needed research in tropical climatology to promote the health and working capacity of tropical populations". pp. 526-528 in Tropical Health. Washington, D. C.: National Research Council. National Academy of Sciences

Ferderber, Murray B. and Houghten, F. C. 1941. "Effective temperature scale", Journal of the American Medical Association, Vol. 116, pp. 474-477

Folk, G. Edgar Jr. 1966. Introduction to Environmental Physiology. Philadelphia: Lea and Febiger

Fourt, Lyman and Hollies, Norman R. 1970. Clothing: Comfort and Function. New York: Marcel Dekker

Fox, R. H. 1965. "Heat", pp. 53-79 in The Physiology of Human Survival (O. G. Edholm and A. L. Bacharach, eds.). New York: Academic Press

Gagge, A. P. 1940. "Standard operative temperature, a generalized temperature scale, applicable to direct and partitional calorimetry", American Journal of Physiology, Vol. 131, pp. 93-103

_____. 1970. Thermal Interchanges with the Environment. Draft manuscript.

Gagge, A. P., Burton, A. C., and Bazett, H. C. 1941. "A practical system of units for the description of the heat exchange of man with his environment", Science, Vol. 94, pp. 428-430

Gagge, A. P., Graichen, H., Stolwijk, J. A. J., Rapp, G. M., and Hardy, J. D. 1968. "ASHRAE-sponsored research project RP-r1 produces R-meter", ASHRAE Journal, Vol. 10, pp. 77-81

Givoni, B. 1962. "The influence of work and environmental conditions on the physiological responses and thermal equilibrium of man", Arid Zone Research (UNESCO), Vol. 24, pp. 199-204

_____. 1963. Estimation of the Effect of Climate on Man: Development of a New Thermal Index. Haifa: Israeli Institute of Technology (Building Research Station, Technion) (Research Report)

Givoni, B. and Sohar, E. 1968. "Rectal temperature in the prediction of permissible work rates in hot environments", International Journal of Biometeorology, Vol. 12, pp. 41-50

Glaser, E. M. 1963. "Circulatory adjustments in the arid zone", pp. 131-151 in Environmental Physiology and Psychology in Arid Conditions. Reviews of Research. Paris: UNESCO

_____. 1966. The Physiological Basis of Habituation. London: Oxford University Press

Goldman, Ralph F. 1967. "Systematic evaluation of thermal aspects of air crew protective systems", Conference Proceedings No. 25, Advisory Group for Aerospace Research and Development, Paris

_____. 1968. Assessment of Thermal Comfort and its Effects on Performance. Paper presented at Symposium on Aeromedical Aspects of Troop Transport and Combat Readiness, Brussels, Belgium, Oct. 10-11, 1968

_____. 1969. Environmental Limits, their Prescription and Proscription. Paper presented at the NATO Advanced Study Institute on Human Factors/Ergonomics, Palermo, Sicily, Sept. 24 - Oct. 8, 1969

_____. 1971. Personal communication

Goldman, Ralph F., Green, Edward B., and Iampietro, P. F. 1965. "Tolerance of hot, wet environments by resting men", Journal of Applied Physiology, Vol. 20, pp. 271-277

Goromosov, M. S. 1958. ["Combined indexes of the effect of various meteorological factors on the organism and criticism of them"], Gigiyena i Sanitariya, Vol. 7, pp. 66-71 (translated by U. S. Joint Publications Research Service, 11 pp.)

Gregorczuk, M. 1968. "Bioclimates of the world related to air enthalpy", International Journal of Biometeorology, Vol. 12, pp. 35-39

Haffernon, George A., Hittner, Herman J., and Kocis, Stephen L. 1953. "Effective temperature as a measure of heat effect", U. S. Armed Forces Medical Journal, Vol. 4, pp. 73-80

Haines, G. F. Jr. and Hatch, T. F. 1952. "Industrial heat exposures--evaluation and control", Heating Ventilating, Vol. 49, pp. 93-104

Haldane, J. S. 1905. "The influence of high air temperatures", Journal of Hygiene, Vol. 5, pp. 494-513

Hatch, Theodore F. 1963. "Assessment of heat stress", pp. 307-318 in Temperature: Its Measurement and Control in Science and Industry, Vol. III, Part 3 (James D. Hardy, ed.). New York: Reinhold Publishing Corp.

Henschel, Austin, Taylor, Henry Longstreet, and Keys, Ancel. 1943. "The persistence of heat acclimatization in man", American Journal of Physiology, Vol. 140, pp. 321-325

Hertig, B. A. and Belding, H. S. 1963. "Evaluation and control of health hazards", pp. 347-355 in Temperature: Its Measurement and Control in Science and Industry, Vol. III, Part 3 (James D. Hardy, ed.). New York: Reinhold Publishing Corp.

Hevener, Osborn T. 1959. "All about humiture", Weatherwise, Vol. 12, pp. 83-85

Hislop, Livingstone R. Jr. 1960. "The wet bulb-globe temperature index", U. S. Armed Forces Medical Journal, Vol. 11, pp. 709-711

Höfler, W., Ladipoh, J., and Lasser, U. 1969. "Beziehung zwischen Schweiszmenge, Verdunstung und Körpertemperatur bei der Akklimatisation in künstlichen feuchtheiszem Klima", Internationale Zeitschrift für Angewandte Physiologie, Vol. 27, pp. 34-42

Houghten, F. C. and Yagloglou, C. P. 1923. "Determining equal comfort lines", Transactions of the American Society of Heating and Ventilating Engineers, Vol. 29, pp. 165-176

Hounam, C. E. 1967. "Meteorological factors affecting physical comfort (with special reference to Alice Springs, Australia)", International Journal of Biometeorology, Vol. 11, pp. 151-162

Iampietro, P. F. and Goldman, R. F. 1965. "Tolerance of man working in hot, humid environments", Journal of Applied Physiology, Vol. 20, pp. 73-76

Ionides, Margaret, Plummer, J., and Siple, P. A. 1945. Report from Climatology and Environmental Protection Section, September 17, 1945. Washington, D. C.: Office of the Quartermaster General, U. S. Army

Johnson, Victor. 1965. Heatstroke in the South African Gold Mines. Seminar presented to the U. S. Army Research Institute of Environmental Medicine, 5 March 1965

Kerslake, D. McK. 1958. "Humidity and heat stress", pp. 66-68 in Proceedings of the Sixth International Congress on Tropical Medicine and Malariology, Lisbon, Sept. 5-13, 1958, Vol VI

Kraning, Kenneth K. II, Belding, Harwood S., and Hertig, Bruce A. 1966. "Use of sweating rate to predict other physiological responses to heat", Journal of Applied Physiology, Vol. 21, pp. 111-117

Kuno, Yas. 1956. Human Perspiration. Springfield, Ill.: Charles C. Thomas

Ladell, William S. S. 1964. "Terrestrial animals in humid heat: man", pp. 625-660 in Handbook of Physiology. Section 4: Adaptation to the Environment (D. B. Dill, ed.). Washington, D. C.: American Physiological Society

_____. 1965. "Water and salt (sodium chloride) intakes", pp. 235-290 in The Physiology of Human Survival (O. G. Edholm and A. L. Bacharach, eds.). London. Academic Press

Lee, Douglas H. K. 1964. Heat and Cold Effects and their Control. U. S. Department of Health, Education and Welfare. Public Health Service. Public Health Monograph No. 72

Lee, D. H. K. and Henschel, A. 1963. Evaluation of Thermal Environment in Shelters. Cincinnati: U. S. Dept. of Health, Education and Welfare. Division of Occupational Health (Technical Report No. 8)

_____. 1966. "Effects of physiological and clinical factors on response to heat", Annals of the New York Academy of Sciences, Vol. 134, pp. 743-749

Lee, Douglas H. K. and Vaughan, John. 1946. "Temperature equivalent of solar radiation load on man", International Journal of Biometeorology, Vol. 8, pp. 61-69

Leithead, Charles S. 1967. "Prevention of the disorders due to heat", Transactions of the Royal Society of Tropical Medicine and Hygiene, Vol. 61, pp. 739-745

_____. 1968. "Occupational heat stress, and man's responses", Bulletin of the World Health Organization, Vol. 38, pp. 649-657

Lind, A. R. 1963a. "Tolerable limits for prolonged and intermittent exposures to heat", pp. 337-345 in Temperature: Its Measurement and Control in Science and Industry, Vol. III, Part 3 (James D. Hardy, ed.). New York: Reinhold Publishing Corp.

_____. 1963b. "Practical assessment of intolerably hot conditions", Federation Proceedings, Vol. 22, pp. 891-892

_____. 1963c. "A physiological criterion for setting thermal environmental limits for everyday work", Journal of Applied Physiology, Vol. 18, pp. 51-56

_____. 1964a. "Physiologic responses to heat", pp. 164-195 in Medical Climatology (Sidney Licht, ed.). Baltimore: Waverley Press

_____. 1964b. "The assessment, management and control of heat stress", pp. 1-124 in Heat Stress and Heat Disorders (C. S. Leithead and A. R. Lind eds.). Philadelphia: F. A. Davis

Lind, A. R. and Bass, David E. 1963. "Optimal exposure time for development of acclimatization to heat", Federation Proceedings, Vol. 22, pp. 704-708

Lind, A. R. and Hellon, R. F. 1957. "Assessment of physiological severity of hot climates", Journal of Applied Physiology, Vol. 11, pp. 35-40

Löfstedt, Börje. 1966. Human Heat Tolerance. Lund: University of Lund, Department of Hygiene

Lustinec, K. 1965. [Evaluation of the Work and Climatic Load]. Thesis, Medico-Hygienic Faculty of Charles University, Prague (in Czech)

Machle, Willard and Hatch, T. F. 1947. "Heat: man's exchanges and physiological responses", Physiological Reviews, Vol. 27, pp. 200-227

Macpherson, R. K. 1958. "Heat tolerance", pp. 34-39 in Proceedings of the Sixth International Congress on Tropical Medicine and Malariology, Lisbon, Sept. 5-13, 1958, Vol. VI

_____. 1960. Physiological Responses to Hot Environments. London: HMSO (Medical Research Council, Special Report Series No. 298)

_____. 1962. "The assessment of the thermal environment", British Journal of Industrial Medicine, Vol. 19, pp. 151-164

Majumdar, N. C. and Bardhan, S. 1966. "Evaluation of thermal stress on personnel operating under desert conditions", pp. 32-43 in Human Adaptability to Environments and Physical Fitness (M. S. Malhotra, ed.). Madras: Defence Institute of Physiology and Allied Sciences

Majumdar, N. C. and Sharma, R. N. 1960. "Practical evaluation of solar heat load on human body", Defence Science Journal, Vol. 10, pp. 32-41

McArdle, W., Dunham, W., Holling, H. E., Ladell, W. S. S., Scott, J. W., Thomson, M. L., and Weiner, J. S. 1947. The Prediction of the Physiological Effects of Warm and Hot Environments: the P4SR Index. London: HMSO (Medical Research Council. Royal Naval Personnel Research Committee. Report No. 47/391)

McCance, R. A., Rutishauser, I. H. E., and Knight, H. C. 1968. "Response of sweat glands to pilocarpine in the Bantu of Uganda", Lancet, March 30, 1968, pp. 663-665

McKarns, J. S. and Brief, R. S. 1966. "Nomographs give refined estimate of heat stress index", Heating, Piping and Air Conditioning, Vol. 38, pp. 113-116

Missenard, H. 1948. "Equivalences thermiques des ambiances; equivalences de passage, equivalences de sejour", Chaleur et Industrie, Vol. 24, pp. 159-163

Molnar, G. W., Towbin, E. J., Gosselin, R. E., Brown, A. H., and Adolph, E. F. 1946. "Water, salt, and heat exchange of men in tropical and desert environments", American Journal of Hygiene, Vol. 44, pp. 411-433

Murray, R. H. and Ross, J. C. 1965. "Cardio-vascular effects of brief, intense thermal pulses in man", Federation Proceedings, Vol. 24, p. 280

Nelson, N., Eichna, L. W., Horvath, S. M., Shelley, W. B., and Hatch, T. F. 1947. "Thermal exchanges of man at high temperatures", American Journal of Physiology, Vol. 151, pp. 626-

Napier, L. Everard. 1943. The Principles and Practice of Tropical Medicine. Calcutta: Thacker, Spink

Nevins, R. G., Rohles, F. H., Springer, W. E., and Feyerherm, A. M. 1966. "A temperature-humidity chart for thermal comfort of seated persons", ASHRAE Transactions, Vol. 72, Part I, pp. 283-291

Newman, Russell W. 1971. Personal communication

Pepler, R. D. 1963. "Performance and well-being in heat", pp. 319-336 in Temperature. Its Measurement and Control in Science and Industry, Vol. III, Part 3 (James D. Hardy, ed.). New York: Reinhold Publishing Corp.

_____. 1964. "Psychological effects of heat", pp. 237-253 in Heat Stress and Heat Disorders (C. W. Leithead and A. R. Lind, eds.). Philadelphia: F. A. Davis

Perry, I. C. 1967. "A medical survey of climatic effects on army aviators operating in South Arabia", Journal of the Royal Army Medical Corps, Vol. 113, pp. 213-219

Peters, D. W. A. 1966. A Review of the Wet Bulb Globe Thermometer Index as a Means of Evaluating the Hazards of a Thermal Environment. Paper presented at the Ergonomics Research Society Meeting, Army Personnel Research Establishment, Ministry of Defence (Army Department), Farnborough, U. K., June 1966

Peterson, Jack E. 1970. "Experimental evaluation of heat stress indices", American Industrial Hygiene Association Journal, Vol. 31, pp. 305-317

Renbourn, E. T. 1965. Human Factors Problems in Tropical Climates, Particularly of Jungle Warfare. Paper presented to the Eighth Commonwealth Defence Conference on Clothing and General Stores, Australia

Richards, C. H., Stoll, A. M., and Hardy, J. D. 1951. "The panradiometer", Review of Scientific Instruments, Vol. 22, pp. 925-934

Robinson, S., Turrell, E. S., Belding, H. S., and Horvath, S. M. 1943. "Rapid acclimatization to work in hot climates", American Journal of Physiology, Vol. 140, pp. 168-176

Robinson, S., Turrell, E. S., and Gerking, S. D. 1945. "Physiologically equivalent conditions of air temperature and humidity", American Journal of Physiology, Vol. 143, pp. 21-32

Roller, W. L. and Goldman, R. F. 1967. "Estimation of solar radiation environment", International Journal of Biometeorology, Vol. 11, pp. 329-336

_____. 1969. "Response of swine to acute heat exposure", Transactions of the American Society of Agricultural Engineers, Vol. 12, pp. 164-174

Sargent, Frederick II and Zaharko, Daniel S. 1962. "Medical-meteorological forecasting--an application of fundamental bioclimatological concepts", pp. 174-195 in Biometeorology (S. W. Tromp, ed.). Oxford: Pergamon Press

Sen, Rabindra Nath. 1966. "Studies on tolerance to dry and wet heat in industrial occupations in India", pp. 73-81 in Human Adaptability to Environments and Physical Fitness (M. S. Malhotra, ed.). Madras: Defence Institute of Physiology and Allied Sciences

Sibbons, J. L. H. 1966. "Assessment of thermal stress from energy balance considerations", Journal of Applied Physiology, Vol. 21, pp. 1207-1217

Smith, F. E. 1955. Indices of Heat Stress. London: HMSO (Medical Research Council Memorandum No. 29)

Sohar, E. and Adar, R. 1964. "Sodium requirements in Israel under conditions of work in hot climate", pp. 55-62 in Environmental Physiology and Psychology in Arid Conditions. Proceedings of the Lucknow Symposium. Paris: UNESCO

Sohar, E., Tennenbaum, J., and Robinson, N. 1962. "A comparison of the cumulative discomfort index and corrected effective temperature, as obtained by meteorological data", pp. 395-405 in Biometeorology (S. W. Tromp, ed.). Oxford: Pergamon Press

Stephens, Joseph C., Marks, Lawrence E., and Gagge, A. Pharo. 1969. "The quantitative assessment of thermal discomfort", Environmental Research, Vol. 2, pp. 149-165

Suggs, Charles W. 1965. "Some responses of humans to thermal radiation", Journal of Applied Physiology, Vol. 20, pp. 1000-1005

Taylor, N. B. G., Kuehn, L. A., and Howat, M. R. 1969. "A direct-reading mercury thermometer for the wet bulb globe temperature index", Canadian Journal of Physiology and Pharmacology, Vol. 47, pp. 277-279

Tennenbaum, J. and Sohar, E. 1962. "The significance of the discomfort index", pp. in Biometeorology (S. W. Tromp, ed.). Oxford: Pergamon Press

Tennenbaum, J., Sohar, E., Adar, R., Gilat, T., and Yaski, D. 1961. "The physiological significance of the cumulative discomfort index", Harefuah, Vol. 60, pp. 319-

Terjung, W. H. 1967. "The geographical application of some selected physio-climatic indices to Africa", International Journal of Biometeorology, Vol. 11, pp. 5-19

_____. 1968. "World patterns of the distribution of the monthly comfort index", International Journal of Biometeorology, Vol. 12, pp. 119-151

Thom, Earl C. 1959. "The discomfort index", Weatherwise, Vol. 12, pp. 57-60

Thomson, M. L. 1954. "A comparison between the number and distribution of functioning eccrine sweat glands in Europeans and Africans", Journal of Physiology, Vol. 123, pp. 225-233

Vernon, H. M. 1932. "The measurement of radiant heat in relation to human comfort", The Journal of Industrial Hygiene, Vol. 14, pp. 95-111

Vogt, J. J. and Metz, B. 1966. "Nomogrammes de prédiction du débit sudoral requis ou de la durée-limite d'exposition en fonction des caracteristiques d'une ambiance thermique. In IVe Congrés d'Ergonomie, Marseille, octobre 1966

Webb, C. G. 1959. "An analysis of some observations of thermal comfort in an equatorial climate", British Journal of Industrial Medicine, Vol. 16, pp. 297-310

_____. 1960. "Thermal discomfort in an equatorial climate". Journal of the Institution of Heating and Ventilating Engineers, Vol. 27, pp. 297-304

Webb, Paul. 1963. "Pain limited heat exposures", pp. 245-250 in Temperature: Its Measurement and Control in Science and Industry, Vol. III, Part 3 (James D. Hardy, ed.). New York: Reinhold Publishing Corp.

Wenzel, H. G. 1965. "Untersuchungen des Erholungsverlaufes nach Hitzarbeit", in Proceedings of the 2d International Congress on Ergonomics, Dortmund, 1964

Winslow, C.-E. A., Herrington, L. P., and Gagge, A. P. 1936. "A new method of partitional calorimetry", American Journal of Physiology, Vol. 116, pp. 641-655

_____. 1937a. "Physiological reactions of the human body to varying environmental temperatures", American Journal of Physiology, Vol. 120, pp. 288-299

_____. 1937b. "Relations between atmospheric conditions, physiological reactions and sensations of pleasantness", American Journal of Hygiene, Vol. 26, pp. 103-115

Woodcock, Alan H. 1962. "Moisture transfer in textile systems", Textile Research Journal, Vol. 32, pp. 628-723

Woodcock, A. H. and Breckenridge, J. R. 1965. "A new method for completely describing man's thermal environment", pp. 17-23 in Humidity and Moisture: Measurement and Control in Science and Industry, Vol. , Part (Arnold Wexler, ed.). New York: Reinhold Publishing Corp.

Woodcock, A. H., Pratt, R. L., and Breckenridge, J. R. 1957. Theory of the Globe Thermometer. Natick, Mass.: Environmental Protection Research Division, Quartermaster Research and Engineering Center (Research Study Report, BP-7)

Woodcock, A. H., Powers, J. J. Jr., and Breckenridge, J. R. 1956. Man's Thermal Balance in Warm Environments. Natick, Mass.: Environmental Protection Research Division, Quartermaster Research and Development Center (Technical Report EP-30)

Wyndham, C. H. 1962. "Research needs in climatology", pp. 533-540 in Tropical Health. Washington, D. C.: National Research Council. National Academy of Sciences

_____. 1964. "Performance and comfort standards in relation to climate", pp. 189-198 in Environmental Physiology and Psychology in Arid Conditions. Proceedings of the Lucknow Symposium. Paris: UNESCO

Wyndham, C. H., Bouwer, W. van der Merwe, Paterson, H. F., and Devine, M. G. 1953. "Examination of heat stress indices", A. M. A. Archives of Industrial Hygiene and Occupational Medicine, Vol. 7, pp. 221-233

Yagiou, C. P. and Minard, David. 1957. "Control of heat casualties at military training centers", A. M. A. Archives of Industrial Health, Vol. 16, pp. 302-316

ADD:

Alexander, L. 1945. The Treatment of Shock from Prolonged Exposure to Cold, Especially in Water. Washington, D. C.: U. S. Department of Commerce (Report 250)

Daily, W. M. and Harrison, T. R. 1948. "A study of the mechanism and treatment of experimental heat hyperpyrexia", American Journal of the Medical Sciences, Vol. 215, pp. 42-55

Gregorczuk, M. 1968. "The distribution of air enthalpy on the globe", Zeitschrift für Meteorologie, Vol. 20, pp. 204-208

John B. Pierce Laboratory, New Haven, Conn. (J. D. Hardy, ed.). 1970. Proceedings, Symposium on Physiological and Behavioral Temperature Regulation, 19-23 August 1968. 24th International Congress of Physiological Sciences. Springfield, Illinois: C. C. Thomas

ADDENDA AND ERRATA

The discontinuities and extended period of time, as well as other special conditions, under which this report was finally readied for publication, have combined to give the author opportunity to consult a number of additional relevant source materials which had not been available or had not come to his attention prior to the preparation of the text multiliths in final form. These addenda ultimately became so bulky that one more complete revision of the manuscript should clearly have been made. Unfortunately, time does not permit it. Rather than ignore entirely these late contributions, or reserve them for some possible future revision (which, given the uncertainties of life's course, might never eventuate), I have simply decided to knowingly offend aesthetic and scholarly sensibilities by appending the new data, along with some errata. The items are arranged in order of the chapters and pages of the main text, and should most profitably be consulted in close conjunction therewith.

Page xi. The Hindu astronomical solar year varies slightly from the sidereal solar year, with the result that the former has been traveling slowly forward in our calendar year, about one day in 115 1/5 years. Thus, while Cait 1 may occur as late as April 10 now, in 820 A. D. it was never later than March 31.

I, p. 2, par. 2. Preliminary results of the 1971 census show a total Indian population of 547 million, an increase of 24.6% over the 1961 census figure of 439 million (and 14 million fewer than expected by official projections) (New York Times, April 13, 1971, p. 8). If we can assume that the population growth in Uttar Pradesh and in Bihar have been the same as the national average, then the mid-1971 populations of these two states are about 92 million and 58 million, respectively.

I, p. 6, par. 1. See Fonseca (1971) for a definition and description of terms used to identify the spatial components of a North Indian city.

I, p. 6, par. 3. Real per capita income (calculated at 1951 prices) had risen to Rs. 322.50 per annum in 1968, but slipped to Rs. 321.40 in 1969, as a result of a drop in agricultural production (Indian Economic Diary, Nov. 12-18, 1970, p. 562). However, a measure of the rate of inflation in India is the fact that the per capita income at current prices was Rs. 551.40 in 1968, exactly double that in 1951.

I, p. 7. On Aug. 14, 1970, India News reported the following "selected indicators of economic development" for India:

	Fiscal 1951	Fiscal 1969
Food production (million metric tons)	54.9	94.0
Industrial production (1960 = 100)	55	171
Electricity (installed capacity) (million Kw)	2.3	14.3
Literacy rate (per cent)	17	33
Life expectancy at birth (years)	35	52

I, p. 9. In 1961, 64% of Indian rural households owned more than 1/2 acre of land; 36% owned 1/2 acre or less (Indian Institute of Public Opinion, 1968, p. 27)

I, p. 12, line 19. Pandey (1961) has studied storms in the hot season in North India, and has classified them into three categories: (1) dust-storms or andhīs (Bhoj. ānhīs); (2) thunder-storms; and (3) dust-raising whirlwinds. In Bihar in an average year there are 20 dust-storms and 14 thunder-storms, and meteorologically they differ from each other only in their relative contents of dust and of water. The most frequent gust velocity reached is about 30 to 40 mph. The āndhīs bring a welcome and rapid drop in temperature of about 6 --8°F.°, but relative humidity generally increases slightly, by anywhere from 1% to 10%.

> The dust-storms or thunder-storms which generally burst in the afternoon or evening after the heat of the day are caused by convective interaction of the dry west wind blowing at high level and the damp air currents from the Bay of Bengal . . . (Pandey 1961, p. 44)

Interestingly, even the scanty rainfall provided by these evening storms is greatly depended on for the growth of mango and lichee crops, and by farmers for the preparation of fields for the "Bhadai" crop (see p. 118n above).

II, p. 22n. Anūpa means literally "the land lying on the seacoast", and the early poet Kalidasa described it as part of the "Western Marches", an actual area with a capital and a king (in the region of present-day Rajputana?) (Chakladar 1963, p. 442).

II, p. 26, par. 4. Muslim influence is held responsible for the chattā, a feature commonly found in North Indian cities, especially Agra, Lucknow, and Delhi (although in the last city many were destroyed in the Mutiny, and present city by-laws forbid them). Bhargava's dictionary defines chattā as "a covered footpath", but the word actually refers to a place where the upper story of a residential structure crosses over a galī or narrow street-passage in an Indian city. This provides, according to Fonseca, a device for relief from the hot climate in cities, presumably through affording shade (Fonseca 1971, pp. 74-75).

II, p. 26n. According to a recent item in the magazine Swastha Hind, the Institute of History of Medicine and Medical Research (located in Delhi, and closely associated with the long-existing Hamdard Unani medical research laboratories), is presently engaged in a new translation of Avicenna's Canon of Medicine into English, and will also soon publish the hitherto unpublished clinical work of Rhazes, Al-Fakhir.

II, p. 28, par. 2. And much later, around 1900, an observer in north-western India marveled:

> The whole population has a sweet tooth of perfectly preposterous size . . . (Menpes 1905, p. 100)

Of course, that sweet tooth was largely satisfied by crude sugar preparations, and any adverse effects on dental health may also have been reduced by the frequent practice of having the sweets at the beginning of the meal (Pennell 1912, p. 32).

II, p. 30, par. 2. In the early days of the East India Company, the whole of interior North India lying between Bombay and Calcutta was usually referred to as "up-country", and here the bungalow reigned supreme. In fact, the kind of massive two- and three-storied European houses so well described, for example, by "A. U." (1873, pp. 51ff) were largely limited to Calcutta, often referred to as the "City of Palaces". Even in Bombay, most of the Europeans favored bungalows, whose most distinctive feature was said to be

> ". . . the wide verandah, its shady over-hanging roof supported on low arches and open to the garden. The trouble was that, once you had seen one Bombay bungalow, you had seen them all." (Edwardes 1969, p. 23)

The typical "up-country" bungalow is engagingly described by Edwardes (Ibid., pp. 64ff). He notes that it was always sparsely furnished, with the floors bare during both hot weather and the rainy season. "A. U.", although admitting that many of the Calcutta "Palaces" were elegantly appointed, also sensed a certain barrenness in them, owing to the fact that window-draperies could not be used (because of obstructing the air in calm conditions, and endangering every light article in reach in storms) and that walls could not be papered, but rather had to be painted.

> In bedrooms this bareness is still more striking, because the walls are often whitened, and their great height gives them a barn-like aspect, especially as all the beams of every ceiling must be exposed to view, in order that the ravages of the white ant may be more readily detected. ("A. U." 1873, p. 75)

Many writers of the time spoke of the wet season moldiness which could devour a carpet in a few days. However, "A. U.", found that, at least for part of the year,

> The floors of most Calcutta rooms are covered with a cool, pretty kind of matting, woven of a species of long, tough grass, which retains a pale green hue, and even a faint, fragrant smell, for a considerable time. (Ibid., p. 76)

II, p. 31. The tahkhānā or underground room mentioned on p. 27 was apparently not a common feature of Anglo-Indian bungalows, being found only in some of the larger homes and towns and more in the western than in the eastern Gangetic plains.[1] Dr. Fayrer's house, in the Lucknow Residency, was equipped with such a room and during the 1857 siege of the Residency many women and children took refuge in it to escape the Sepoy artillery (see Fayrer 1900, pp. 32ff). They found it fairly tolerable so long as the dry season lasted, but by July 11 it had become so damp and oppressive and the mosquitoes so numerous that most of the women preferred the hazard of death from enemy fire upstairs to sleeping in the tahkhānā. However, they continued to eat their scanty rations there in order not to attract more flies, which had become so numerous as ". . . to be a perfect torment" (Ibid., p. 186).

---

[1]Honigberger states that ". . . the inhabitants of India, native and European, are compelled to pass their time during the day in cellars beneath the ground . . . [or else in tattie-protected rooms]" (Honigberger 1852, p. 166). But he could scarcely have reference to others than the highest social class.

In later years, in the Panjab, Thoburn (1946, p. 124) drew up an ingenious plan to cool houses by circulating air through tunnels going to 15 ft. below the ground surface, but I cannot say if his scheme was ever successfully applied.

II, p. 32, par. 1. One writer says that during hot days

> . . . round the tatties people gather as round a fire at home. (Blanchard 1867, p. 55)

After the railroad came to India, the coach windows were fitted with tatties in the summer (Munson 1913, p. 82).

II, p. 33, line 1. The punkah frame was actually covered over with canvas, rather than being, as it might seem to the casual observer, a solid plank. Or, in a more stylish version, the frame might be of carved mahogany, with red plaited silk instead of canvas (Blanchard 1867, p. 53).

II, p. 33, line 9. In a typical Anglo-Indian bungalow that had changed owners several times,

> "Irregular holes appeared at intervals over the wall for the accommodation of punkah-ropes, each tenant having fancied a different seat outside for his punkah-wallah". (Edwardes 1969, p. 150)

Stamp notes that the punkah string was not infrequently attached to and operated by the big toe of the punkah-wallah! (Stamp 1964, p. 46)

II, p. 33, line 19. Another building where a veritable army of punkahs might be deemed necessary (as many as 20 or 30 of them in simultaneous action, according to one observer) was the station church. And here too

> . . . it destroys all the architectural beauty of the building; and at first, till the preacher becomes accustomed to it, it is a great source of annoyance. (Brittan 1880, p. 44)

II, p. 33, line 35. A long frill on the punkah was especially useful in areas where mosquitoes were a plague, as in Calcutta (Blanchard 1867, p. 54). This writer also notes that

> Punkahs are most peculiar to the Bengal Presidency. In Madras they are less used, and in Bombay less than in Madras. (Ibid., p. 54)

Punkahs were rarely taken down in Bengal, although they were removed for the 4 or 5 cooler months in other areas. (However, due to the relatively continuous high humidity in Calcutta, khaskhas tatties were apparently not in use there, for "A. U." noted that she did not see her first tatties until a visit to Madras.)

II, p. 35. The question naturally arises as to how Anglo-Indians, prior to the introduction of electricity, could enjoy very much interior lighting at night in the face of wind draughts produced by punkahs. Probably they could not. But Dr. Munson, in her book of memoirs, refers to the use of

> . . . a big punkah lamp (a lamp with a shade surrounding all the sides and curving over the top, protecting it from the breeze of the punkah). (Munson 1913, p. 78)

Unfortunately, I have no further information on this "punkah lamp".

II, p.37. On the principle that ". . . you cannot keep a room very cool unless you keep it rather dark", the dining room and drawing room in many Anglo-Indian bungalows were placed in the center of the building, and no light entered except through the outer apartments (Blanchard 1867, p. 50). This arrangement would also help to reduce the plague of flies over the table at dinner, regarding which Mrs. Meer notes:

> Their numbers exceed all calculation; the table is actually darkened by the myriads, particularly in the season of the periodical rains. The Natives of India use muslin curtains suspended from the ceiling of their hall at meal times, which are made very full and long, so as to enclose the whole dinner party and exclude their tormentors. (Meer 1832, Vol. I, p. 96)

In Virginia Lloyd Hunt's manual, How To Live in the Tropics, there is a description of a very interesting invention to make midday naps more comfortable, especially in hot humid conditions. She calls it a "Dutch wife",

> . . . a hollow roll made of matting or lightly woven strips, or sometimes a bolster of linen filled with some light material, but always large enough for you to take in your arms and wrap your legs about. She prevents the heating sensation of having arms and legs touch other parts of your body. (Hunt 1942, p. 40)

I have no confirmation that the "Dutch wife" was used in British India, although anyone who has had the experience of tossing restlessly on conventional mattresses during hot days or nights in India can well believe the device might be helpful.

II, p. 38, line 8. For example, the indigo planters of the Bengal Presidency were famous for the strange variety of their headgear:

> "Some resemble copper boilers in shape, with broad brims, and innumerable air-holes; others have a peak in front, and an apron behind . . ." (Edwardes 1969, p. 139)

II, p. 38, line 13. Speaking of the European custom around 1800 in Benares, Rev. Tennant said:

> Here our whole dress is white cotton, and must on account of the heat of the climate be changed twice or thrice every day. (Tennant 1804, Vol. II, p. 194)

II, p. 39. E. T. Renbourn's various articles are essential reading for an understanding of the medical myths and concepts which underlay European culture in India and other tropical countries in the early 19th century and earlier. A fundamental idea at the time was that most Europeans, after arrival in the tropics, developed some form of "seasoning fever" ("seasoning" was the word then used as an approximate equivalent of today's "heat acclimatization"). The "seasoning flux" was thought to be brought about by such actions as exposure to rain, by remaining too long in sunlight or in night air, by exercising too much, by "heating the body or inflaming the blood", by experiencing conditions which suddenly check perspiration, or by drinking large draughts of liquor or bathing in cold water when the body is heated (Renbourn 1963, p. 194).

Renbourn speculates that the 19th century Anglo-Indian fear of insolation of "solar phrenitis"--an inflammation of the brain or its membranes--received an enormous fillip from the experiments prior to 1839 of John Davy, who claimed to have demonstrated the penetration of sunlight or ardent solar rays through dried human skulls (Ibid., p. 197). He also credits the military hygienist, Andrew Duncan, with later popularizing the idea that sunstroke was primarily due not to heat but to the actinic or ultra-violet solar radiation, which could penetrate clothing, unless this were of red, orange or black color. Duncan, for his part, accords the honor of being the first to advocate actinism to one Col. F. N. Maude, an amateur photographer who, drawing upon his knowledge of emulsion and filter effects connected with light, one day had the brilliant idea of sewing red and yellow linings in his clothing and head covering. Although he had three times previously been a victim of "sunstroke", and considered himself extremely sensitive to sunlight, he obtained immediate and dramatic relief from the sun's effects, and passed on his experiences to

Lord Roberts, the Commander-in-Chief of British forces in India. This eminent man followed Maude's example and

> . . . for the first time in his long experience found comfort under the Indian sun. (Duncan 1907, p. 83)

There then followed a veritable fad of wearing orange or red anti-actinic garments. Dignified military officers, some of whom had suffered from distressing headaches in the hot weather, adopted the orange-red spine pads, helmet linings, and even, in one case at least, a flannel shirt on their marches and ". . . never again suffered from the sun".

The alleged success of colored linings for headgear in the British army in India resulted in a recommendation by an American commander in the Philippines for an experimental evaluation of solar ray-protective clothing (see Phelan 1910). And so it was that, in November 1908, about 5000 hat linings and 5000 sets of orange-red cotton underclothing (an 8.5 oz. undershirt and 8.9 oz. drawers) arrived from the U. S. A. for testing. Since nearly 80% of the undershirts, with typical military foresight, were too small in size, ultimately only 500 men were chosen as the hapless guinea pigs who would wear the bright apparel, along with a control group of 500 outfitted in the standard white underwear. Medical follow-ups did not show much difference between the two groups, except in the single factor of excessive perspiration, which was more frequent among wearers of the orange-red underwear. Subjectively, at the end of the test, 16 brave soldiers awarded preference to the new outfits (some because it did not show dirt so readily!), 54 pronounced themselves indifferent, while the great majority voted in favor of the familiar white garb. Their responses may well have been influenced, as the author admitted, by the merciless ridicule to which the wearers of the anti-actinic red underwear were subjected by their fellows. However, tests made by wrapping thermometers in the two colors of fabric showed conclusively that the white was cooler, due to less absorption of radiation. Needless to say, the American army herewith declined to brighten the Philippine landscape in the manner of their British cousins in India.

In India, the actinic ray theory mixed with and in the lay mind became hopelessly confused with the earlier cerebral or "ardent ray" theory of solar hazard or "sunstroke", and with a third or "ocular" theory as well, the idea that the sun's rays could stroke down a man directly through his unprotected eyes. In the heyday of the actinic theory enterprising manufacturers in England developed a special "solaro" cloth, in which orange, red or black fibers were woven into the fabric (see Sambon 1907, p. 69). Red linings were being recommended by at least some tropical hygienists (e.g., Hunt 1942, p. 24) at least up to World War II and, according to Renbourn, the "solaro" cloth can still be purchased from certain long-established outfitters (Renbourn 1965, p. 35).

II, p. 40. The red flannel spine pad, tied by tapes around neck and body, had largely gone out of style in the British Asian tropics by 1921, even though the usual strip of red cloth to protect the spine and sewn into jackets endured longer (Stephens 1966, p. 106). However, the solar topi was still very much *de rigueur*, the classic warning being that

> . . . no one should step out, even for a few moments, without first putting on his sun-hat. (Elwin 1913, p. 277)

In fact,

> So insistent were the authorities on protecting the head from the sun that several major companies in the East reserved the right to repatriate instantly any of their white staff who refused to conform. (Stamp 1964, p. 40)

Dr. Stamp also describes an alternate item of headwear, more elegant than the pith helmet, which English ladies in South Asia wore (in Burma, at least, and probably also in India). This was called a "double terai" (*Ibid.*, p. 40). Renbourn (1962, p. 9) presents photographic illustrations of some of the many available varieties of topis,

> . . . their usefulness generally varying in inverse proportion to their beauty. (Macleod 1938, p. 142)

II, p. 41. As an Indian-authored treatise on hygiene and public health in 1915 phrased it,

> Wool is, as a rule, heavy and often irritates the skin when worn next to it. But this has a therapeutic value depending on its stimulating the circulation. (Ghosh and Das 1915, p. 238)

However, the wool worn next to the skin was usually smooth, soft, and of close texture. The flannel binder worn around the waist was called a cummerbund (from Hind. *kamarband*, "waist-bind"). It was especially worn during the night sleeping hours, when the covers might be tossed off and the abdomen chilled by a punkah draught (*Ibid.*, p. 240). The study, definitive and nonpareil, of the flannel binder or cholera belt, and buttressed by an impressive bibliography, is that of Renbourn (1957).

Tropical "experts" and hygienists only slowly and reluctantly bade farewell to this accoutrement, whose prolonged period of favor may be partly attributed to habituation, in view of the statement so often found in the literature that

> . . . deprivation conveys a distinct sensation of discomfort. (Renbourn 1957, p. 221)

<u>II, p. 42, par. 1</u>. Few among the junior British civil servants, educators, and the like were permitted to pass the hot season in the mountains (see Bell 1939, p. 45). The reader is referred to R. D. Macleod's <u>Impressions of an Indian Civil Servant</u> (pp. 141-150), for a most revealing description of a British official's typical daily regimen and duties in the "mofussil". Here is also contained a vivid account of the miseries endured in the hot season, a time patently not relished by the author:

> You can never forget the hot weather. When present, it weighs you down in a permanent state of stupor and irritability; when past, its memory haunts you like a nightmare; when impending, the anticipation fills you with foreboding. (Macleod 1938, pp. 142-143)

It is clear that "official cold weather", as it was in fact officially designated during the Anglo-Indian era, has varied from time to time and place to place. From the standpoint of the British civil servant, "official cold weather" was the period within which Government provided no funds for punkah-pulling, and this, according to Macleod, was from Oct. 15 to Apr. 15. He admits, however, that

> . . . in private houses--and, I fear, in those parts of Government offices where the European sits--the punkah season usually extends a fortnight or so in each direction. (Macleod 1938, p. 142)

Rowe (1881, p. 187) makes about the same punkah-season estimate. However, Mrs. Meer states that in the homes of the Muslim nobility of Lucknow the punkahs and fans were in constant use by day and night during 8 months of the year (Meer 1832, Vol. I, p. 84).

<u>II, p. 44n</u>. A minority opinion on the desirability of the siesta has been stated by D. H. K. Lee:

> I personally do not favor the siesta, on the grounds that a normal lunch hour is long enough for a mid-work break, that a practicable siesta is not long enough for sleep

> and comes at a time when sleep is difficult, that it means starting the day twice and that it subtracts from the cooler hours in which relaxation and sleep are more possible and beneficial. (Lee 1950, p. 727)

Dr. Lee recommends the arranging of some mild physical activity to counter the depressing effects of the day's hottest hours. Newcombe, when working in a government office in Madras, was advised by the medical officer to fight off mid-afternoon drowsiness by drinking hot coffee and bathing his face in a basin of cold water (Newcombe 1905, p. 217).

II, p. 45, line 28. And to assist the reader in his imagination of the staggering level of alcoholic consumption among the early East India Company gentlemen and troops in India (a subject often remarked by writers of the time), Rev. Tennant's indignant description merits repetition:

> It was not uncommon for his acquaintances, when a friend had laid in a fresh stock of wines, to meet in his house at dinner, in order to give their judgment of its quality; and on these occasions, perhaps, the whole chest of claret was consumed at one sederunt. The consequences were often so fatal, that the next meeting of this social crew was not infrequently to witness the funeral of one of their companions. (Tennant 1804, (Vol. II) p. 77)

And so far as the combination of liquor and the intensely hot climate is concerned,

> It is not uncommon to find, at that period, the whole officers of a battalion, except one or two, incapable of doing duty; and this without extraordinary or alarming complaint. (Ibid., pp. 78-79)

Somewhat later, contradictory medical opinions on the use of alcohol in hot weather in India were heard. Some recommended total abstinence, but others felt that "moderate use of gentle stimulating liquors stopping short of intoxication" was desirable for "supporting the perspiration" (Renbourn 1963, p. 199). (Note, however, that the word "perspiration" at that time did not mean "liquid sweat", but rather bore a meaning of "the insensible perspiration from the skin and lungs" [Renbourn 1957, p. 212n]).

II, p. 45n. It would be a great mistake to believe that this diet extended beyond a very small circle of highly favored gentry in Lucknow, but if Mrs. Meer's account is correct, it reveals a more nutritious selection of lunch items than that favored by Englishmen:

> It is the custom among Natives to eat fruit after the morning sleep, when dried fruits, confectionary, radishes, carrots, sugar-cane, green peas, and other such delicacies are likewise considered wholesome luxuries, both with the ladies and the children. A desert [sic] immediately after dinner is considered so unwholesome, that they deem our practice extremely injudicious. (Meer 1832, Vol. II, p. 332)

II, p. 46. Presumably, meal hours among the British community in India were at least indirectly influenced during the 18th and 19th centuries by the regimen current "at home" in England. And that this went through a marked evolution in the period between 1780 and 1870 is made abundantly clear in Arnold Palmer's fascinating *Movable Feasts* (1952).

It is interesting to note that the cooking area, or kitchen, of the typical Anglo-Indian bungalow was not located in the main house, but rather in a separate small building (which, incidentally, the English memsahib was frequently advised by books on Indian housekeeping to avoid if she wanted to retain her appetite!) The separate establishment was in order to avoid the heat and smell of the cookery, according to "A. U." (1873, p. 51). Needless to say, the European mistress of the house did no cooking and, in considering the rigors of this task even today in Indian conditions (see p. 168), it is well to recall Mrs. Brittan's somewhat dire pronouncement:

> It is impossible for any European here, even of the very lowest position, to do their own cooking; the heat of the fire, with the heat of the weather, would quickly kill them; and you really cannot superintend it, as you would faint in a very few minutes in the cook-house. (Brittan 1880, p. 95)

The separate cook-house made for other ramifications:

> The fact that every dish has to be carried some distance from the cook-room to the table, and the constant use of the punkah during meals, make it necessary that everything intended to be warm should be served on hot-water plates. ("A. U." 1873, p. 73)

And the passage of the food from kitchen to dining room exposed the bearers to another common hazard--birds such as kites and crows which were ever alert to swoop down and snatch food from their very hands ("A. U." 1873, p. 96)

II, p. 97, par. 1. Bhupal Singh notes that people in the British community at an Indian station (in a large one, at least) might not even know by sight many of those on their social list, due to the "not-at-home box" (B. Singh 1934, p. 22).

II, p. 48. One more avian observation is irresistible:

> . . . the sweet melody of the birds of England is absent. No Indian bird knows how to sing. Some make a brave attempt, but they break down after the third note. . . . Though Indian birds cannot sing, they shout, and scream, and whistle. (Elwin 1913, p. 185)

II, p. 49, line 24. Water and saltpetre were used to cool beverages, in the manner described, by those too poor to afford ice, or when ice was not available (Honigberger 1852, p. 165).

II, p. 50, line 1. The cowrie shell was used extensively as currency in India up to perhaps the middle 1800's. Mrs. Meer reported its value in Lucknow about 1830 to be from 60 to 90 for one pice, the exact number fluctuating with grain prices (one pice = 1/64 rupee) (Meer 1832, Vol. I, p. 40n). While the monetary value of a cowrie would appear to be infinitesimal, it must be recalled that a rupee in the days of the East India Company commanded far more purchasing power than it does today. In fact, Rev. Tennant, in his description of the Benares region about 1800, noted that Europeans there had fixed a price of 3 sheep for a rupee, or about tenpence each in British coin. He admitted, however, that

> This is lower than the real value, and must operate as a grievance; it explains the reason why the natives are so averse to sell their production to Europeans. (Tennant 1804, Vol. II, p. 200)

II, p. 50, par. 4. It is probable that the system of informally organized ice-making by subscription, under the supervision of one of the station residents who offered to serve as comptroller, was in existence even before 1830. One subscription or ice-ticket cost about Rs 3 in large stations, and about £ 6 in small ones, and the usual allotment (about 1830) was in the vicinity of 4 pounds daily (Edwardes 1969, p. 73). Each ticket-holder sent his servant before dawn to the ice-deposit, and the precious allotment was carried home either in a canvas bag enveloped in a thick blanket, or else

> . . . in baskets made for the purpose well wadded with cotton and woolen blankets; conveyed home, the basket is placed where neither air nor light can intrude. Zink bottles, filled with pure water, are placed round the ice in the basket, and the water is thus cooled for the day's supply. (Meer 1832, Vol. I, p. 68)

According to Edwardes, other items, such as wine, beer, butter, and fruit had priority over water. At any rate--and this statement seems almost incredible--

> The bag of solid ice is in the center of all these, and imparts to each an equal coldness. These four pounds of ice, if properly managed, and the air kept out of the basket, will cool an inconceivable quantity of fluids, and will last for twenty-four hours--that is to say, there will be some ice remaining when the fresh bag is brought in. (Edwardes 1969, p. 77)

Another commentator states:

> The ice is not very solid or very clear, but it cools your wine, beer, and soda-water most effectively, and is even available for ice-puddings and creams (Blanchard 1867, pp. 57-58)

With respect to the making of iced delicacies, we have Mrs. Meer's description of the "burruffwallah" (barafvālā) or "ices man" in Lucknow:

> They can produce ices at any season, by saltpetre, which is here abundant and procured at a small price . . . . The ice is usually carried about in the evening and considered a great indulgence by the Natives. The ice-men bring round both iced creams, and sherbet ices, in many varieties; some flavoured with oranges, pomegranates, pine-apple, rose-water, etc. (Meer 1832, Vol. I, pp. 67-68)

It seems quite certain, however, that the patronage of this vendor was limited entirely to the luxury-minded and wealthy courtiers surrounding the Muslim ruler of Oudh.

II, p. 50, line 38. It may seem surprising that the ice-deposit could remain unmelted through the long Indian summer. However, any rural American whose memory antedates the large-scale introduction of refrigerators and freezers will remember the coolness of storage cellars, and the underground temperature gradient is scientifically reported:

> When the ground temperature is 122° F. it may be only 83° F. at a depth of 1 foot 3 inches, while at 6 feet it may fall as low as 68° F. with considerable humidity. (Coon 1953, p. 26)

This temperature gradient also underscores the attractions (at least, in very dry heat) of the tahkhānā (see p. 460 above).

II, p. 51. Macleod notes that the typical Anglo-Indian houses also used one or more devices for keeping food cool in the hot season. One of these was a pot of damp, porous clay. Another was a basket made of khuskhus and slung from a tree (Macleod 1938, p. 122).

II, p. 52, line 5. That the change to air conditioning in Indian colonial bureaucratic echelons did not always come without some entrenched hostility is revealed in an amusing anecdote related by Megaw (Remarks in Lee 1935, pp. 23-24). He describes his efforts about 1918 to have a cool room installed in the offices of the School of Tropical Medicine in Calcutta. The engineering staff raised one objection after another, and when it finally went into use in 1920, the officials sitting there initially expected all manner of unpleasant effects on their health. The local Calcutta newspaper commented sarcastically:

> "What would the men who defeated swarthy hordes and crossed plains and rivers and scaled mountains and founded empires, and, having performed these mighty feats, quenched their thirst in brandy concoctions and foaming English beer, what would these men think of the highly-paid officials and business men who must have a temperature of 65° F. before they can undertake the business of the day? Are even our proconsuls deteriorating? Can England hold India only in a temperature of 65° F.?" (Megaw, Remarks in Lee 1935, p. 24)

II, p. 52, line 7. With regard to daily regimen, Elwin complained in 1913 that few European residents any longer followed Bishop Heber's hot-season schedule a century earlier of rising at 3 a.m. and being on horseback by four:

> . . . nowadays the few people who come to India with the intention of conforming to the ancient custom of early morning exercise soon drop it. It is to be regretted that the tendency now is to go to the opposite extreme, and late hours at night, and comparatively late getting up, grows increasingly common. Few people, however, now look upon the midday siesta as a necessity. (Elwin 1913, p. 291)

II, p. 52, line 24. With respect to the topi or pith helmet, there was an interesting custom among Britishers. When an official went on home leave he rather ceremoniously threw his old solar topi overboard when his ship reached Suez. And on the return trip, no matter how hot the passage through the Mediterranean and the northern reaches of the Canal, he would not buy his new topi until the stop at Suez (Stephens 1966, p. 107). Newcomers to India were also expected to outfit themselves at Suez before arrival in Bombay (see Bell 1939, p. 24). For those ill-advised enough to pass through the Red Sea in mid-summer, however, neither a topi nor the ice, punkahs, and salt-water baths provided by the venerable P. and O. Line were always sufficient to stave off collapse, for

> . . . at the height of the hot season, even strong men had been known to die in their berths of apoplexy brought on by the temperature. (Edwardes 1969, p. 147)

Stories and legends, apocryphal or otherwise, abound with respect to the demise of the solar topi in British India. Stamp provides another one, in which the hero was a courageous doctor at the 25th Jubilee of the Indian Science Congress in 1937, who denied the existence of "sunstroke" (as distinguished from the very real and dangerous heatstroke) and who walked about blithely without a hat. The old Indian hands shook their heads, muttered, and waited in vain for the upstart's inevitable collapse and return on a stretcher to England (Stamp 1964, p. 40).

Incidentally, Stamp claims that, while in later years the value of dark sunglasses came to be recognized and they were widely used by Europeans in India, in 1921, on the other hand, he was looked upon as being somewhat peculiar for wearing them (Ibid., p. 40). However, Penbourn (1962, p. 10) notes that, in conformity with the "ocular theory of sunstroke", some medical officers long ago recommended neutral tinted glasses. And according to one book of memoirs,

> Sunstroke is said to be caused by the glare passing through the eyes to the brain. Blue spectacles are worn by those who suffer from glare . . . (Newcombe 1905, p. 75)

But this writer advised side pieces for the sunglasses, so as to prevent the contrast between the dark lenses and the glare from the sides. Mrs. Fisher wore such glasses, with blinders at the sides, on the hot-season train trip across North India which she so graphically describes (Fisher 1926, p. 15). And according to Pym, at about the same time

> The most up-to-date motors in India, such as those belonging to Indian princesses, are usually fitted with a special kind of blue glass which, besides cutting out the glare of the sun, not only allows the person in the motor to see out very clearly, but absolutely prevents the outsider from seeing in. (Pym 1930, p. 191)

Here, of course, both the requirements of purdah and of sun glare reduction were being served.

III, p. 61. While the preceding chapter has described something of the evolution of Anglo-Indian houses, and this chapter will concern itself with typical North Indian houses of today, there is lacking much reference to the Indian houses of a century or two ago. In villages, of course, the change over years and over generations has been more one of degree than of kind. Classic descriptions of the upper-class North Indian zenana, or part of the house where women lived in purdah, in the 1800's are contained in such sources as Meer (1832, Vol. II, pp. 304ff) and Brittan (1880, pp. 55ff). Their description is not so far from being accurate even today with respect to many "old-fashioned" urban families living in old quarters. These accounts emphasize the facts that no doors or windows opened from the zenana onto the outside world, and that the women's rooms were small, dark, and austerely furnished. Inside the women's quarters there were many curtains (pardās, from which the word "purdah" comes), intended to secure degrees of privacy, warmth, and/or protection from flies and sun's glare, depending on whether they were of cotton, wool, or woven bamboo strips.

The men's part of the house, on the other hand, as described by Brittan (Ibid., p. 57), featured one or more large, lofty rooms, where the floor was covered with matting or carpet, on which was placed a large, thick mattress of from 6 to 15 ft. square, covered with a white sheet, and with a number of bolsters and pillows to encourage the gentlemen to loll about, talk, smoke, or gamble. A punkah swung overhead, unlike in the women's quarters, where, even in the case of the noble ladies of the Lucknow court, stirring of the air was dependent upon servants or slaves

> . . . for with them fixed punkahs have not been introduced into the zeenahnah . . . (Meer 1832, Vol. I, p. 84)

Even today, many North Indian homes feature a padded sitting-place on the floor, provided with bolsters and pillows, where the men may take their ease. It is still a small minority of families who eat their meals at a table, rather than sitting on the floor.

III, p. 65, line 9. That "superstition" or taboos might in a few instances have a hand in determining the roof material is suggested by two items in North Indian Notes and Queries (Vol. I, p. 134; Vol. V, p. 197), where it was reported that a certain village, and also a fair-sized town, in Sitapur District both stood out as anomalous in their region because of the complete absence of tiled roofs.

> They say tiles (khaprail) are unlucky, and those who make tiled roofs not only never prosper, but misfortune soon overtakes them and they die. (Ibid., Vol. I, p. 134)

III, p. 67. Visiting the houses of fairly prosperous Jat villagers in the Rohtak area of eastern Panjab, Seymour found most houses to contain one very large room, its roof supported by ornamental brick "moorish" arches, and perhaps four smaller rooms at the back and sides. At midday even the main room was very dark and

> . . . the smaller rooms would often be pitch dark; if you wanted to go into them you had to take a lamp. (Seymour 1953, p. 233)

III, p. 71, line 24. As Mrs. Fisher (1926, p. 25) has noted, the sacredness of the pipal tree in India is not difficult to understand, when one sees its immensity and thefullness of its shade. As to the neem tree, which is so often found in front of the house, everyone affirms that

> . . . it is very conducive to health, to breathe the air through the neam-trees. (Meer 1832, Vol. I, p. 192)

III, p. 72, line 13. Apropos of the older, built-up sections of an Indian city, a sympathetic American visitor has said:

> The narrow streets and absence of windows led one to imagine that many of the houses inside were dark, unventilated holes, and I would have gone away with an utterly false impression of the life of an Indian city if I had seen nothing but the outside. (Cook 1939, p. 322)

She goes on to describe the typical "atrium" style of house, with gardens in the center courts, and ". . . built in a way that made it possible to live outdoors in the midst of the city" (Ibid., p. 323).

In the case of Delhi, Fonseca, in a current issue of Ekistics, has given some quantitative expression to this pattern of living, finding that approximately 25% of the katra area in the vicinity of Chandni Chowk is in fact taken up by private internal courtyards (Fonseca 1971, p. 76). All in all, he suspects that this is a better solution to land use, at least in North India's climate of high heat and dust-storms, than the newer suburbs where

> . . . open space occurs as incidental space between structures, belonging to no one in particular and often used for grazing goats. (Fonseca 1971, p. 78)

By contrast, the inner courtyard is private and personal space, which "compensates for the anonymity and stress of urbanism". It can nourish growing plants, and acts as a gathering place for social and ritual activities.

III, p. 73n. Other criticisms of the architecture in Chandigarh, new capital of the Panjab, so far as its thermal protective qualities are concerned, are reported by Schmid (1961, pp. 35ff).

III, p. 74. Ladell's article on man in humid heat (Ladell 1964) helps put into perspective the North Indian house type in relation to climatic conditions. He notes that indigenous tropical man is almost always forced to make a choice between relative daytime comfort and comparative nighttime warmth. Such peoples as the Malayans choose the former and so build well-shaded houses with wide eaves, large unglazed windows, loosely-boarded walls, and lightly thatched roofs. Such houses have a low thermal capacity and are well ventilated, and thus are comfortable during the midday heat but admit of cold discomfort at night. West

Africans (or, at any rate, northern Nigerians), on the other hand, elect to spend their afternoon work or siestas outdoors under trees, and build thick-walled houses permitting more warmth for indoor sleeping during the several months of the year when nighttime chilling can be severe.

While certain areas of South India adopt something approaching the Malayan pattern, there is no doubt concerning the normal choice in the case of North India, where thick walls are favored. With pakkā construction also,

> Vast thickness and solidity characterize the brick structures, and the abundant use of a most solid and tenacious mortar . . . (Baden Powell 1872, p. 322)[1]

Elwin has graphically described the failure of English missionaries in the vicinity of Poona to understand the thermal preferences of Indian mission workers for whom they built cottages. Although these homes may have seemed far superior to their previous habitations, they contained, in addition to many doors and windows, ventilators in the roof which could not be closed, and so were never liked by the Indian workers.

> In more than one mission school some of the doors and windows have had to be permanently bricked up, because both teachers and children complained so much of the cold. (Elwin 1913, p. 254)

III, p. 76n. Another sensitively-drawn picture of North Indian dust-storms is that of Thakur Rajendra Singh (1926, pp. 25-27). Khushwant Singh, in his premier novel, Train to Pakistan, gives a blow-by-blow account of a dust-storm, which in the modern cities of today within a few seconds can smash the glass panes of windows, carry away roofs of thatch or of corrugated iron sheets, and blow over trees which fall on power lines starting fires and electrocuting passers-by (see K. Singh 1956, p. 109). But the āndhī was causing fires long before the advent of electricity, for Captain Hervey noted that flames, sparked

---

[1] Baden Powell, incidentally, mentions that the old indigenous cement in the Panjab, unobtainable even in his time, and made from an especially pure lime free of ash and impurity, was so strong that a pick could not separate the materials--"the mass had to be blasted with powder like a rock". (Baden Powell 1872, p. 322)

by cooking fires, often consumed the huts of Army camp-followers, as a result of dust-storms (Hervey 1850, Vol. III, p. 32). Other descriptions of the frightful force of the *āndhī* are those of Honigberger (1852, p. 166) and of "A. U." (1873, p. 99).

> These dust-storms are sometimes so thick that, in broad daylight, they will occasionally, for a few minutes, produce as great a darkness as that of night. (Honigberger 1852, p. 166)

And, in the words of that incomparable observer, Mrs. Meer,

> No sound that can be conceived by persons who have not witnessed this phenomenon of Nature is capable of conveying an idea of the tempest. In a few minutes total darkness is produced by the thick cloud of dust; and the tremendous rushing wind carries the fine sand, which produces the darkness, through every cranny and crevice to all parts of the house; so that in the best secured rooms, every article of furniture is covered with sand, and the room filled as with a dense fog . . . and though candles are lighted to lessen the horror of the darkness, they only tend to make the scene of confusion more visible. (Meer 1832, Vol. I, pp. 107-108)

<u>III, p. 76n</u>. I am informed by Mr. J. R. Breckenridge of ARIEM that further investigations carried out in the Ergonomics Laboratory of ARIEM have uncovered some rather significant errors in the studies reported by Roller and Goldman. The latest scientific findings with respect to solar radiation effects on man, including the theoretical basis and models and formulas for practical application, will shortly appear (probably in the *Journal of Applied Physiology*) in papers authored by J. R. Breckenridge and R. F. Goldman.

<u>III, p. 77, line 23</u>. Apropos of the *dhotī's* fanning effect, physiologists have calculated that even the movement of arms and legs while walking (at the speed of 3 mph) results in an increase of apparent wind velocity of about 150 ft/min (Nelson *et al*. 1947, p. 651). While this might appear to make for a significant cooling effect in hot humid conditions (see p. 91), the metabolic cost in walking at 3 mph no doubt more than offsets the apparent advantage.

III, p. 77n. Upon reading the Wisers' recently revised Behind Mud Walls, I realize that my descriptions and definitions of the sārī and the dhotī demand some modification. Dhotī in its original sense is the male dress, as I have described. A sārī is also the traditional dress par excellence of Hindu ladies, and is made of a bolt of cloth long enough to be thrown back over the shoulder if desired. But the North Indian village women generally wear

> . . . a cross between the two, longer and wider than those worn by the men and plainer and scantier than saris. They are usually white with colored borders and with just enough cloth for a few folds in front to make movement easier, and enough to cover the head if drawn straight up the back--not over the shoulder. (Wiser and Wiser 1967, p. 193)

This women's dress is also called dhotī. It becomes thinner with many washings, and also ". . . the warmer the weather, the thinner the dhotis" (Ibid., p. 194).

III, p. 78, par. 2. Crooke mentioned an ". . . umbrella-like hat of straw or bamboo worn by peasants or fishermen in Western India or Bengal . . ." (Crooke 1906, p. 165), but this form of headgear apparently did not exist in the intervening region, which is the focus of the present study.

III, p. 78, line 23. Of the existing literature which provides useful descriptions of everyday life and behavior in India, of the sort which official and historical and "social scientific" studies of the time seldom deigned to record, a sizable segment is made up by books by missionaries. While there is every reason to suspect that the published experiences of many missionaries may have been more or less colored, either by parochial bias, or by access to an artificially limited and unrepresentative segment of the Indian totality, much that is provocative can be found in their observations.

The Rev. A. D. Rowe, for example, has especially noted the fact that Indian children are typically less warmly dressed in winter than adults (as he puts it, they are in fact "often cruelly neglected"):

> It is no uncommon thing to see parents well wrapped up while their unprotected children are shivering with cold. When remonstrated with, they say, "Oh, children do not feel the cold". (Rowe 1881, p. 112)

He also cites a local proverb: "Children and the legs of a stool do not feel cold". A medical official in Lucknow told me that, during the exceptional cold wave of December 1961, his own children suffered chilblains because "they could not be restrained from playing barefoot outdoors" (Planalp 1966, n.p.).[1]

Another missionary writer has sensibly made a point which is no doubt applicable to most North Indians:

> The scanty dress of the Indian arose, not so much because of the hot climate, but because he could only afford a few yards of calico. (Elwin 1913, p. 301)

One may also be pardoned for suspecting that some considerable experience of oppression by the local Raja. by the agents of the Company, or by a combination thereof, may have contributed to the scanty dress in the Benares region described by Rev. Tennant:

> The children, till they are ten or twelve, seldom put on any clothing at all; and after that season a small piece of cloth covering the middle, is the whole attire of the lords of creation in this country. (Tennant 1804, Vol. II, pp. 193-194)

Elwin at several points emphasized the apparent Indian hypersensitivity to cold:

> Boys of the Mission will wear comforters and warm coats well into the hot season if allowed to do so. (Elwin 1913, p. 46)

He notes, however, that

> The Indian deals with cold in quite a different way to those who have been brought up in northern countries. If you give him a comforter, very little of it goes round his neck, but he wraps his head up

[1]It is highly relevant here, and in connection with the general question of footwear in North India, to realize that in India baring the feet (and covering the head) are important in etiquette and ritual, e.g. entering a house, a temple, or the presence of a superior: "It is disrespectful to have covered feet or an uncovered head--just the reverse to our own rules" (Brittan 1880, p. 64)

> in it so that only his eyes and nose are visible, and if his head is warm he does not seem to mind about the rest of his frame, especially his legs, which are generally bare. (Elwin 1913, p. 276)

<u>III, p. 79, par. 1</u>. Anyone with access to a good library of illustrated India travel books spanning the past century can readily, by scanning them in chronological order, see mirrored in the drawings and pictures the gradual demise of the turban in favor of either bareheadedness or

> . . . the adoption of a stupid little cloth cap, as ugly as it is useless. (Elwin 1913, pp. 44-45)[1]

As to the contemporary condition of North Indian headwear, its exceptional heterogeneity is also clearly reflected in published "photographic essays". Keusen (1958), Beny (1969), and Renou (1969) are only a few such examples.

<u>III, p. 79, par. 3</u>. A recent Swiss travel writer asked the high priest of the Sikh Golden Temple at Amritsar the reason for the Sikh prohibition against cutting the hair, and was told:

> Because hair consisted of pigment-carrying cells with a special affinity for the ultra-violet rays of the sun, their role, surely, was evident: to store the solar energy as a perpetual source of power, in much the same way as does the chlorophyll in plants. (Schmid 1961, pp. 187-188)

The priest also cautioned against removing the oils in the hair by using too much soap.

<u>III, p. 80, line 14</u>. The subject of traditional color preferences and taboos in clothing, varying as they do in bewildering fashion from one region and one social or religious group to another in India, is too formidable for description here. Some of its complexity has been suggested by Crooke (1906, pp. 165ff).

It is the long, full skirt for women which in western U. P. has been to a large extent replaced in the past 40 years by the the village women's <u>dhoti</u>. This garment is said to be much more comfortable, is lighter in weight, and can be washed frequently at home. It has a lower initial cost, although it does not wear as long (Wiser and Wiser 1967, p. 194).

[1] It may be of interest to note that the Mahatma did not himself wear a "Gandhi cap". But on hot days he often put a small wetted cloth on his head (Cook 1939, p. 357).

III, p. 81, par. 2. According to Leix, Muslim men (but not women) in India observe a religious taboo against wearing silk. However, the men can and do wear a silk-cotton blend (Leix 1940, p. 1299).

III, p. 81, par. 3. See Gaikwad (1967) for a description of the modern Anglo-Indian (or erstwhile Eurasian) community in India. He notes that Anglo-Indian women rarely wear the sāṛī. In addition to frocks, or to shirt and blouse, in large cities they also wear slacks (Gaikwad 1967, p. 136).

III, p. 82. All the world's experts in the field of environmental physiology, many of whom are cited frequently in the pages of this report, agree that

> Bare arms, and by extension, bare torsos are physiologically desirable in hot-wet climates. . . . Leg covering is also contraindicated; indigenous tropical men do not wear trousers. (Ladell 1964, pp. 650-651)

However,

> The type of clothing worn is seldom if ever determined solely by consideration of thermoregulation. If it were, clothing for work in humid heat should be loose, light-weight, minimal and permeable to water vapour. (Leithead 1967, p. 744)

So much for the July-October period in North India. In hot desert climates, however, which are fairly analogous to April-June in North India, the thermally optimal outdoors clothing is that which reflects, shades off, and insulates against infra-red and solar radiation without significantly impairing the heat loss achieved by perspiration. That is, it should be thin, white, loose and flowing.

III, p. 83. See Whelan et al. 1955 and Woodcock 1964 for authoritative analyses of the insulative and evaporative properties of various textile and clothing fabrics.

III, p. 84, par. 1. In connection with Renbourn's remarks, it may be noted that the efficient evaporation of a liter of sweat from the body of the average man is calculated to remove approximately 580 kcal of heat (Buskirk and Bass 1960, p. 314). But evaporative efficiency may vary greatly depending on dryness or moistness of the air, and even the distribution of sweat over the body. In addition,

> It should be emphasized that only sweat which evaporates possesses "cooling power"; when sweat rolls off the body or is trapped in clothing it contributes nothing to heat loss. (Buskirk and Bass 1960, p. 314)

III, p. 84, par. 2. The importance of psychological factors (which can change as a result of training) relative to the wearing of clothing has been emphasized in a recent authoritative study of clothing materials (Fourt and Hollies 1970). Thus, in the U. S. A., clothing made from filament yarns has been found highly unacceptable to men, but not to women:

> This presumably relates to the fact that most men are normally highly uncomfortable in filament underwear while women are quite accustomed to its definitely cool feel. (Fourt and Hollies 1970, p. 178)

III, p. 84n. As an aside pertaining to bedbugs in North India, when I was there in 1963 it seemed to me that these pests were more prevalent than was the case 10 years earlier. Villagers laughed when I told them this and said, "Well, the Government has sprayed and killed most of the mosquitoes, but in exactly the same proportion that the mosquitoes have decreased, the bedbugs have increased". I was inclined to chalk this up as only an especially charming example of the Indians' sense of humor (and a fine regard for Nature's unwillingness to have her balance disturbed). But lo and behold! A current article in the medical literature, entitled "The problem of resurgent bed-bug infestation in malaria eradication programmes" (Rafatjah 1971), comes to exactly the same conclusion!

III, p. 85, par. 1. Although the question of possible racial differences in sweat gland morphology and activity have been referred to (see p. 424), nothing has yet been said in this study about the possible interrelationships between skin pigmentation and the environment, especially solar radiation. The subject is a difficult and complex one, with more than the normal quota of unanswered questions. In addition to Coon (1953), Garn (1969), and other recent physical anthropological reviews, the reader is referred to Blum (1961) for a discussion of the adaptive value of melanin and other related problems. (See also Coon and Hunt 1965).

However, in the case of North Indian cultural attitudes relative to pigmentation, something should be said. The pervasive favor accorded in India (and especia[illegible] in northern India) to lightness of skin color, and the correspondi[illegible]ke of darker or blacker pigmentation, has been noted by many wri[illegible] on India. For example,

> Many in India think of beauty only in terms of colour. If the skin is fair, everything is all right. I have heard of girls being spoken of as lovely when all they possessed was a chalky complexion. And a man with a light skin gives himself airs and thinks that he is somehow superior to his darker brethren. The colour complex is all-powerful in India. The words Kala and Safaid (black and white) are more fraught with meaning than many a mystic Vedic formula. (Shahani 1939, pp. 304-305)

> . . . a younger sister is sometimes easily married off, while the elder and to your mind more desirable girl cannot find a husband. On inquiring why that is so, you will be told: "But the younger one is whiter!" often with reference to a difference so slight that you haven't even perceived it. I have heard that girls with a lighter coloring need less dowry, that they receive preference in certain schools and so on. Whiter skin is certainly regarded as superior to any other beauty or privilege. (Wernher 1945, p. 219)

> The admiration of a fair colour probably stemmed from the time of the Aryans. It was almost an obsession with our society in a way that I never came across even among the British . . . . From the time a baby is born, its complexion is all important. The second question asked about the newborn is always, "Is it fair or dark?" . . . . When it came to marriage, the first question is, "Is he fair; is she fair". (Tandon 1968, p. 163)

Although Shahani attributes the Indian pigmentation-snobbishness to an aping of British attitudes, Prakash Tandon's hypothesis is probably more valid. Hindu apologists of course assert that the light skin color preference applies mainly to marriage, and that it is at any rate more an aesthetic ideal than an ugly racial or color prejudice in the Western sense. However, there has been some newspaper publicity given to instances of racial prejudice against African students in

India, more in the form of subtle ostracism rather than overt discrimination, and I have heard remarks by East African students in Delhi which appear to confirm this. Schmid made similar observations, and also reports that

> When a public opinion poll was organized at the University of Madras about the students' sympathy for other races the Negroes came out bottom. Merely because their skin is black. (Schmid 1961, p. 166)

This can be further documented in the results of surveys by the Indian Institute of Public Opinion.

III, p. 83, par. 2. About the turn of the century, according to Elwin, a very popular and inexpensive umbrella (in the Poona area) had wooden ribs and was covered with a kind of red and yellow oilcloth. And this was but one of a great variety of "size, shape, color and degree of respectability" of umbrellas to be seen on the streets (Elwin 1913, p. 280). Somewhat later,

> When first the Swadeshi rage took Calcutta, the babus were subjected to no little hardship, for nearly all the umbrellas in the bazaars were of cheap European manufacture, and it took some time before the manufacturers of Indian-made articles could cope with the demand. (Pennell 1912, p. 49)

Prompted by the fear of actinic rays that was widespread around the turn of the century, Fales recommended the use of a black umbrella, white outer clothing, and black underclothing (Fales 1907, p. 592). Fayrer's comment quoted here is misleading, since for those who accepted the actinic theory, it would be the black cloth of the umbrella that would be expected to deflect the solar radiation. A few years later, Freer had high praise for umbrellas:

> . . . the lighter and whiter the clothing, the better is it adapted to protection against the sunlight; indeed, in the Tropics, were it possible, the ideal protection simply would be an umbrella. (Freer 1912, p. 21)

III, p. 83, par. 3. Elwin (1913, pp. 278ff), in his astute analysis of the role of the umbrella in Indian culture, recognizes that

> Its importance is derived more from its recognition as an emblem of dignity than from its practical utility. . . . [That] is shown by the readiness with which it is discarded when convenient, and its bearer sits cheerfully bareheaded in the blazing sun. (Elwin 1913, pp. 278-279)

III, p. 87. The physical and physiological principles which would support the wearing of an outfit such as that shown in Figure 4 are implied in Lee's excellent discussion of clothing in hot dry conditions (Lee 1964). These involve insulation from and exclusion of strong and very hot winds, and for relatively short time spans:

> In such circumstances high heat-capacity clothing is usually desirable, since it will delay the penetration of the more extreme condition. (Lee 1964, p. 580)

And in addition

> The color of the clothing is of surprisingly little importance, especially where the material is thin. (Ibid., p. 578)

III, p. 88, par. 1. Gertrude Williams notes that the black cotton umbrellas are opened not only against rain and sun, but also to protect against the night dews, of which people are very fearful (Williams 1928, pp. 108, 351). She conjures up a not uncommon, if in our eyes slightly ludicrous, sight:

> I remember one hot twilight in southern India, meeting an Indian on the edge of a paddy field. Dressed in a loin cloth, shoes, socks and garters, he was riding a bicycle and carrying an open umbrella. (Williams 1928, p. 66)

Elwin presents an equally incongruous word-picture:

> A mason may be seen sitting at work on a wall with his umbrella in one hand and his trowel in the other. (Elwin 1913, p. 279)

III, p. 88, par. 2. Statements made by Elwin (1913, p. 279) about the use of umbrellas by police in Calcutta and in Bombay generally accord with what I have said here. That is, Bombay police used umbrellas only during the rainy season, whereas in Calcutta they were issued in the hot season also, for parasol purposes. It was only the latter who

> . . . are provided with an arrangement which looks something like braces worn outside, on to which they hang the umbrella when they find it interferes with the discharge of their duties. (Elwin 1913, p. 279)

The explanation for the umbrella's greater popularity in Patna than in Allahabad probably simply reflects the greater proximity of the former city to Bengal, where umbrellas have long been very salient features of dress:

> The Bengali protects his bare head with an umbrella; in other parts of India some form or other of the turban is in vogue. (Pennell 1912, p. 82)

III, p. 89. As has been noted, cow dung plaster is very much used in North Indian village homes, both on walls and floors. According to Kipling, it is accorded cooling as well as purifying attributes:

> During the process of smearing the odour is somewhat strong, but this passes away in an incredibly short time, leaving an undeniable impression of coolness, freshness, and, strange as it may seem, fragrance. Such a floor is soon spoiled by boots, but the Oriental wears no shoes indoors, and is probably right in considering it cool, comfortable, and on the whole, cleanly and wholesome. (J. L. Kipling 1891, p. 167)

III, p. 92, par. 3. Mrs. Meer, in her account of the "vender of fans" in early 19th century Lucknow, describes some of these rather fancy hand fans, including one--obviously a short-lived type indeed--made of [illegible]et-scented flowers over a frame of bamboo. (Meer 1832, Vol. I, p. [illegible]6).

III, p. 98, line 3. The Muslim year is about 354 days long. There is therefore an annual retrogression of this calendar through the Gregorian calendar every 32 1/2 years.

III, p. 98, par. 4. Anent Indian drinking etiquette,

> A Hindu would be horrified at the thought of a public drinking cup. He never touches his lips to a cup, but tilts his head back, and pours the water into his mouth. A boy squats beside the <u>bhisti</u> (sprinkler) in the street. He holds his hands in a funnel shape before his mouth, and the <u>bhisti</u> squirts a stream of water into them. Not a drop is spilled. (Williams 1928, p. 56)

This drinking technique has been pictured many times in books about India (see, for example, J. L. Kipling 1891, p. 110 and Tichy 1938, p. 48).

As to the basis of pollution according to Hindu ideas, another anthropologist has said:

> Spittle is also ritually impure. This is so all over India, especially among the upper castes. A person may not touch his tongue or teeth with his fingers, and should he do so, he has to wash his hands. Elders come down heavily on a child who puts his finger into his mouth. (Srinivas 1952, p. 103)

III, p. 99, par. 3. Few of us will deny the subjective pleasure if not avidity with which we enjoy iced drinks during extreme heat. But what is the biophysical basis for this sensation? In an experimental study reported in 1960, Gold gave one group of subjects water at body temperature, and another group ice-water. He calculated that, theoretically, 37 small calories or .037 kcal of body heat should be neutralized for every gram of ice-water imbibed (37 kcal/liter). Although the use of ice water would thus seem of marginal value in its effect on the body's total heat equation (see Appendix C), Gold judged that, in a controlled ambient temperature of 130° F., the use of ice-water prolongs the period of subjective comfort by about 75 - 100% (Gold 1960a, p. 940).

III, p. 99, par. 4. There is a famous old Indian device for carrying water which should be described here--the goatskin bag (generally called masak in Hindi-speaking India). Although some farmers, especially Panjabi Muslims, are described as using the masak (called kūnī in Panjabi) domestically, when traveling or working in fields at a distance from the house (Baden Powell 1872, p. 325), it was (and is) mostly associated with a particular occupational type, the bhistī. The bhistī may occasionally still be seen in India today, employed in laying the dust on city streets, or transporting water for cement mixing, etc. But in an earlier time, before water mains were extensively laid, they were far more in evidence than today, serving thirsty travelers, and being an essential accompaniment to British and Indian military forces (Rudyard Kipling's famous "Gunga Din" was a bhistī).

It is not surprising to learn that many Hindus refuse(d) to drink water from the masak, which consists simply of the flayed skin of a goat,[1] with the legs sewn up and the throat, ingeniously closed with a

[1] Mrs. Brittan says that the masak is made of the skin of a young buffalo, rather than a goat. Her observation, if correct, might apply to some specific locality, perhaps in Bengal. (See Brittan 1880, p.62)

thong, serving as a pouring spout. Western observers have often marveled at the skill of the bhistī, who

> . . . can direct a thin stream into the mouth or hand of a thirsty passenger, or fill a decanter without spilling a drop, or water a road with a far-reaching spray like that of a watering-cart, or empty his burden into a bath-tub or a mortar-heap in a trice. (J. L. Kipling 1891, pp. 105-107)

The legs of the masak are fastened to straps, which pass over the bhistī's left shoulder, holding the bag firmly on his back. Since the heavy weight is supported by the left hip, the bhistī must lean toward the right to hold his balance, and it has been said that a lifetime of such work gradually gives the body such a list that the bhistī's profession is obvious even when he is not carrying anything! (Macleod 1938, p. 127)

III, p. 106, line 9. Many descriptions of the street-sleepers in Indian cities exist in the literature. These are, however, rather more characteristic of the two great port cities, Bombay and Calcutta, than of the inland cities of the plains. In Bombay, for example,

> They fit one next to the other with their white togas wrapped about them, so close that a child could not walk between. Back of the outer line, with their heads nearer the walls, is another row of figures spreading on and on down the street, looking like chalk-marks on the pavement. (Gardner 1939, p. 330)

In a treatise which otherwise tends to denigrate Indian culture and conditions, the following words by Rev. Rowe strike one as an almost lyrical possible explanation for the Indians' hot-season regime:

> The days being for the most part exceedingly hot and oppressive, while the nights are cool and refreshing, it is not strange that the latter should receive much of the life and activity which in other countries belong to the former. The beautiful moonlight, charming beyond description, and clear enough for reading and writing, is both a wonder and a delight to us of northern latitudes. (Rowe 1881, p. 185)

III, p. 106, par. 1. While Sahgal's observations about the irregularity of eating and sleeping may apply particularly to her family and friends (an upper-class urban milieu, in Allahabad), they are close enough to general application to merit quotation:

> Routine applied no more to sleeping than to eating. People slept when they were sleepy. Children played till they were exhausted, falling asleep wherever they happened to be. They would then be carried to their rooms and put to bed. Regularity and discipline in daily life were "western". (Sahgal 1962, p. 205)

This is especially applicable to children, who in villages also are said to

> . . . eat when hungry, and sleep when weary. (Wiser and Wiser 1967, p. 149)

III, p. 107, par. 3. With respect to the rooftop rooms, such as were seen in the Panjab region of northwest India a century ago, Baden Powell wrote:

> . . . various small and often oddly shaped rooms are constructed, looking like towers and turrets from below. They are constructed for coolness, and to enable the inmates to enjoy the evening or the morning breeze. (Baden Powell 1872, p. 323)

III, p. 107, line 10. Pennell, writing about an unspecified region of northern India (but probably the Panjab), found that nearly everyone retired in the hot season after an 11 a.m. meal (the first of the day), the women in the house, and the men outside under the trees ". . . or in any shady place, especially if one can be found near the well or by the riverside" (Pennell 1912, p. 212). Nor did they get up and go to work again until nearly 4 p.m.!

III, p. 116, par. 1. Nag's comparative study of human fertility in nonindustrial societies fails to throw any light on the seasonal patterns of sexual behavior or of conceptions in India. He reports that the days on which coitus is forbidden for religious reasons are widely scattered through the year, and are different for Hindus and for Muslims (Nag 1962, p. 51).

A recent paper on birth rate in a rural area of Germany shows that

> . . . more babies are born in the period when there is less work to be done . . . (Nurge 1970, p. 1438)

However, the fact that the urban birth curve in North India is similar to, but more exaggerated than, that of the rural areas, suggests that seasonality of women's labor is probably not a discernible factor in the Indian birth curve. I am not aware of any study which gives data or estimates as to the seasonality of time and/or intensity of the work expenditure of women in North India. Insofar as one can judge from Hopper's figures (Hopper 1955, pp. 146-147) based on a single year's inquiries in the village of Madhopur, relating only to "productive agriculture' and failing to differentiate between men's and women's work, the two periods of least work are about May 15 - August 15 and the first two weeks of September.[1] Agricultural work activities are at their peak in late November and early December (paddy harvest and winter crop irrigation), with a secondary high in the second half of March (rabi harvest). I see no clear relationship between these North Indian seasonal work fluctuations and the seasonal cycle of conceptions and births.

III, p. 119. This statement well describes the North Indian farmer's hot-weather work schedule:

> People living in tropical climates have learned to reduce their muscular activity during the hot periods of the day. This results in decreased heat production at the time when heat elimination is most difficult. (Burch and DePasquale 1962, p. 180)

III, p. 120, par. 2. Most of the Indian industries which are apt to be unduly inflictive of heat stress on their employees are the same found in temperate countries: textile processing and certain segments of the glass, rubber, plastics, steel and mining industries (Schamadan and Snively 1967, p. 785). This is especially true of textile weaving and processing, where an artificially produced humidity is required for optimum efficiency due to the fabric properties. The work load and thermal stress in relation to physiological responses of workers have been especially studied in cotton mills and soap factories in Bombay (Sen et al. 1964a, 1964b), and also in the Kolar gold mines (Caplan 1944).

---

[1] It may be noted that these periods coincide fairly closely with the times of maximum heat stress in North India.

III, p. 122, line 3. In connection with Indian attitudes to the monsoon, see S. S. Gupta 1963.

III, p. 126, par. 1. Although I have not yet seen it, judging from its title, the article by K. A. Hasan scheduled to appear in the first issue of the new journal Ethnomedizin will contain much information relevant not only to culinary rituals but also to broader questions of the medical aspects of diet in North India (see Hasan 1971).

III p. 128, par. 1. In From Fear Set Free, Nayantara Sahgal provides some eloquent examples of the rigidity of ethnic or sectional food habits in India. She claims that communities from other parts of India, although settled in Allahabad for several generations, continued to eat only their own (Kashmiri, Malabari, etc.) foods (Sahgal 1962, p. 205). The large Allahabad hospital made no attempt to provide food for patients, simply allowing their relatives to cook for them on little stoves on the hospital verandah or grounds:

> "The Bengalis like fish and rice. The Punjabis eat bread and meat. Some people like one kind of 'dal' and others prefer a different kind. Are we to put plenty of spice in the food or just a little? Are we to prepare it in mustard oil, coconut oil, groundnut oil or ghee?" (Sahgal 1962, p. 125)

From a recent study of the Indian student community in a large American university, Gandhi also reports that

> . . . regional differences and preferences for certain types and styles of cooking also formed certain clusters. (Gandhi 1970, p. 96)

The Indian students in this situation found that a regime of cooking together by turns and sharing food in a group was the best arrangement for them because of "their peculiar food habits, and a preference for particular kinds of food" (Ibid., p. 96).

III, pp. 130ff. The following references were inadvertently omitted from this chapter bibliography:

Cupps, P. T., McGowan, B., Rahlmann, D. F., Reddon, A. R., and Weir, W. C. 1960. "Seasonal changes in the semen of rams", Journal of Animal Science, Vol. 19, pp. 208-213

Grierson, George A. 1926. Bihar Peasant Life. Patna (2d ed.)

Singh, R. L. and Singh, K. N. 1968. "Eastern Uttar Pradesh", pp. 56-105 in India: Regional Studies (R. L. Singh, ed.). Calcutta: Indian National Committee for Geography

IV, p. 139, par. 2. Durnin and Passmore (1967, pp. 108-109) opine that the FAO formula is, if anything, too generous in estimating temperature effects on resting metabolism, and in fact probably allows for some reduction in physical activity with increasing temperature. They generalize that

> Resting metabolism rates are some 5 to 15 per cent lower in the tropics. This amounts to a daily energy expenditure of 50 to 200 kcal, depending on the size of the individual. (Durnin and Passmore 1967, p. 107)

Wilson, reviewing some 200 studies of climatic effects on BMR, was impressed above all by the conflicting evidence relating to virtually every question. He concluded, however, that there is significant lowering of the BMR in Europeans who move from the temperate zone to the tropics, although it is less than has often been claimed, simply because the present standards for temperate zone basal metabolism are probably 5% to 10% too high (Wilson 1956, p. 531). It is necessary to caution that the BMR is extremely difficult to measure accurately. And, secondly, individual variations are enormous:

> Not only does the basal heat production vary from subject to subject, but the apparent energy expenditure on work and the every-day activities of life varies widely between individuals. (Collumbine 1950, p. 651)

And this statement is not as self-explanatory as it might seem. Thus, Collumbine studied 12 medical students in Ceylon, among whom the basal heat production ranged from 840 to 1536 calories per day, the average net food calorie intake ranged from 1806 to 2313 calories, and the excess of calories consumed over basal metabolism ranged from 410 to 1260. Yet, all 12 students had very similar activities, maintained constant body weights, and were under continuous observation to preclude any artifactual effects on the study. The author concluded, not too helpfully for anyone inclined to minimize the refractory role of individual differences, that

> Presumably the efficiencies of digestion, absorption, and utilization of food, the specific dynamic action of food and the mechanical efficiency of muscular effort all may vary between individuals and so account for the different calorie needs of these subjects. (Collumbine 1950, p. 652)

<u>IV, p. 140, line 16</u>. It appears that lower voluntary food intake in hot weather is mostly, although not entirely, associated with simultaneous lower voluntary energy expenditure. Where the rate of work required is fairly high and is held constant, differences in calorie consumption from season to season, in American studies, at least, are negligible. In a classic study of food consumed in mess halls in U. S. Army training camps, the lowest average intakes were in the spring months of March - May (3570 calories), while the highest were in the autumn months of September - November (3960 calories), and during the hottest season, June to August, they were also fairly high (3790 calories) (Howe and Berryman 1945, p. 591).

<u>IV, p. 141</u>. While I do not really wish to seem over-zealous in stressing the inadequacy and confusion of scientific evidence about nutrition and heat stress, a very recent, informed, and thorough review of the effects of thermal stress on human performance makes the following remarkable statement with respect to our knowledge of nutritional relationships:

> Information regarding the type and amount of food best tolerated under conditions of thermal stress is currently unavailable. (Jones 1970, p. 30)

<u>IV, p. 142</u>. In 1927 Bazett could state flatly:

> The tendency of individuals living in a warm climate to avoid high protein diets with their marked specific dynamic action and to choose a diet richer in carbohydrates is well known. Fats are also less palatable in warm climates . . . (Bazett 1927, p. 537)

Apparently this conventional belief is now open to some question, and <u>at high rates of energy expenditure</u>, at least,

. . . any heat production from the specific dynamic action of proteins is of no consequence. That it moreover is not measurable has been shown. (Machle and Hatch 1947, p. 218)

IV, p. 143. A good bibliographical review of the relationships between ambient temperature, physiological stress, and animal metabolism and nutrition in India is that of Srivastava and Kaur (1965). However, it does not deal with the human situation.

IV, p. 143n. Ladell (1957) has elsewhere discussed at some length the role of salt in human nutrition in the heat. Calling salt man's first addiction, he speculates that

When man, the hunter, became man, the farmer, he added salt to his vegetable pap because salt gave it the taste of blood. (Ladell 1957, p. 196)

Ladell finds it suggestive that many of the salt springs in the Middle East are pigmented almost the color of blood due to micro-organisms growing in them, and that there are etymological relationships in several ancient languages between the roots for "salt" and for "royal". Thus, salt was a luxury for early man, whose ancestors

. . . had an active adrenal cortex with ample aldosterone[1] conserving his very limited salt intake. (Ibid., p. 197)

Seeming to verge at times on a jihad against the pernicious effects of salt (or, at least, of its over-use), Ladell cites evidence that Indonesian peasants remain healthy and active with a daily salt intake of 3 g. But this is still well above his 17 meq estimate quoted here.

Incidentally, the contention has been made, in all seriousness, by Prof. Hans Kaunitz that the historically increasing salt use--far beyond what is physiologically required--in human society since its evolution from hunting to farming, then to intensive food production and urban life, is a result of more "emotional stimulation":

. . . the quickened pace of a more complicated society demands persons with a heightened responsiveness . . . (Kaunitz 1956, p. 1144)

---

[1]Relative to the role of aldosterone in electrolyte metabolism, see p. 534 below.

He theorizes that salt has a stimulating effect on the body, including the adrenal glands, which may also bring about changes in the emotional sphere, making for a "greater responsiveness" of people, and perhaps accounting in part for the ancient reverence for salt.

IV, p. 144, line 2. With respect to the alleged differences in flavor and in nutritional qualities between tropical and temperate-zone plants (and much the same thing can be said in the context of some of the very latest disputations regarding "natural" or "organic" versus hybridized, chemically-fertilized, and "enriched" foods), it is always interesting to see how poles apart can be taste perceptions and subjective responses. In the case of India, witness the statement made a century ago by Abbe Dubois:

> The climate, which is the chief cause of the degeneration of the human race in these countries, exercises a no less fatal influence in the animal and vegetable kingdoms. Green stuff, roots, and fruits are for the most part insipid and tasteless, and do not possess half the nutritive value of those grown in Europe. (Dubois 1906, p. 320)

And, on the other hand, we have the remark of Mrs. Vijay Lakshmi Pandit, attributed to her by her daughter, about peas at her home in Allahabad:

> ". . . the vegetables in America look wonderful, but they haven't as much taste as ours. Those great big perfect American peas have no taste at all, while these tiny ones are sweet and delicious." (Sahgal 1962, p. 141)

IV, p. 144, line 36. The ICMR's energy allowances are remarkably close to those recommended by the Food and Nutrition Board in the United States, whose recently scaled down goals are 2800 kcal for men and 2100 kcal for women, with further decrements with age up to 28% beyond age 75 (National Academy of Sciences. National Research Council, 1968).

IV, p. 145, par. 1. Since the publication of McArthur's article, Durnin and Passmore have provided figures on energy expenditures in India on certain agricultural activities:

Mowing	5.1 - 7.9 kcal/min
Watering	4.1 - 7.5 kcal/min
Weeding, digging and transplanting	2.3 - 9.1 kcal/min

(Durnin and Passmore 1967, p. 67)

However, the range of these calculated expenditures is too large to make them very helpful, nor do they tell us anything about typical durations of such work. For purposes of comparison, the ICMR's "heavy work rate", on the basis of the reference man of 55 kg., amounts to an energy output of only 4.6 kcal/min. On an earlier occasion (Passmore and Durnin 1955, p. 833) the same authors asserted that a 24-hour "endurance limit" can be theoretically calculated--that is, the daily working capacity within which there is neither evidence of fatigue, rise in body temperature, or accumulation of lactic acid. This endurance limit is about 5 cal/min (for 8 hours of work), equivalent to a daily walk of 30 miles, and requiring a caloric consumption of 4300 calories (allowing for 500 calories during sleep and 1400 calories for leisure time, in addition to the 2400 calories at work).

> This probably represents the upper rates of daily energy expenditure that can be maintained regularly in heavy industry. (Passmore and Durnin 1955, p. 833)

However, over shorter periods (of several days or weeks) much higher work rates have been recorded, e.g., among lumberjacks, while "unduly heavy" rates of more than 12.5 cal/min can be maintained for very short bursts.

IV, p. 148, par. 1. The Wisers noted exactly the same response in village Karimpur (Mainpuri District) to improved corn varieties, which were welcomed the first couple of years because of their yield and the good price they brought in the market. But then,

> . . . the women found the larger kernels hard to grind for the daily cakes and both men and women were sure that flat cakes of the new corn were not so easily digested as those from the old. Now there is a compromise; a number of farmers raise enough of the old for family use and some of the new for the market, while others have reverted to the old. (Wiser and Wiser 1967, p. 161)

IV, p. 151n. Probably dried ginger has very wide provenance in northern India as a maternal post-partum ingredient. It would not be at all surprising to learn that some large commercial manufacturer has by now packaged it for brand-name sale. However, the exact composition of the post-partum food no doubt varies considerably. In Madhopur it is dried ginger mixed with wheat flour, gur, dried fruits such as raisins, dates, and coconuts, and ghee. About 300 miles to the southwest, among the somewhat less sophisticated Kurmi castes, the mother is not allowed to eat for two days after childbirth, then is given a special dish: balls of dried ground ginger mixed with cow's milk, along with half a liter of cow's milk, some gur, and balls of turmeric powder mixed with ghee (Thaliath 1962, p. 151).

IV, p. 154. Mrs. Meer, with reference to mangoes, says:

> Mangoes are luscious and enticing fruit; the Natives eat them to an excess when they have been some hours soaked in water, which, they say, takes away from the fruit its detrimental quality; without this preparatory precaution those who indulge in a feast of mango are subject to fevers, and an increase of prickly heat . . . . even biles [boils], which equally prevail, are less troublesome to those persons who are careful only to eat mangoes that have been well soaked in water. (Meer 1832, Vol. I, pp. 47-48)

She goes on to say that mangoes (or, indeed, any fruit) were never eaten after dinner, and that the invariable practice was to drink milk immediately after eating mangoes. A second observer confirms:

> The mango-fruit has its corrective, that is, milk. The natives believe, that on eating half a hundred and drinking a cup of milk afterwards, digestion is rendered easy. (Honigberger 1852, p. 305)

IV, p. 157, line 7. Honigberger, India's pioneering homeopathic doctor, had a high regard for this "poor man's sharbat":

> Their simple and favorite beverage is . . . sherbet, i.e. water sweetened with raw sugar, and therefore they generally enjoy good health. (Honigberger 1852, p. 167)

IV, p. 157n. William and Fanny Workman, who in 1904 left a rather unique record of pioneering bicycle tours extending over many hundreds of miles across the Indian countryside, in hot weather and cold, have made some very interesting observations of the problem of thirst:

> It is a painful, torturing thirst, which no amount of liquid seems to quench till some hours have elapsed. We found that, after riding the greater part of the day in a temperature of 160° Fahr. or upwards in the sun, the insatiable craving for water did not cease, drink as much as we would, till far into the night. One one occasion after a ride of sixty miles in the heat we reached a railway station about six p.m. In the course of the next two hours we drank three quarts of tea and thirteen bottles of soda without causing any marked diminution in the feeling of thirst. (Workman and Workman 1904, p. 118)

This was in addition to the 2 or 3 quarts of water carried in flasks which each consumed during the course of the day. This couple concluded, on the basis of ample experience, that weak tea relieved their thirst in the evenings better than anything else (Ibid., p. 119). And their belief, interestingly enough, entirely coincides with that expressed long before by Honigberger:

> It is not always, however, that cold drinks are the most effective for quenching the violent thirst experienced in the hot season; on the contrary, my own experience teaches me that the more of these which are taken, the more the thirst increases; whilst a cup of warm tea or coffee with milk, produces a contrary result. and should therefore be used in preference to cold beverages in such cases. (Honigberger 1852, p. 165)

III, p. 158, par. 2. Banafshā or violet is another popular syrup flavor (especially among Muslims), which should be specially mentioned here. Two interesting descriptions of the sherbet-sellers' shops and wares, and the indigenous tastes in sweetened drinks, in 19th century northwestern Indian cities are those of Honigberger (1852, p. 165) and Menres (1905, p. 101). The former praised highly the virtues of phālsā, and noted the popularity of distilled essence or syrup of "bedemusk, the flowers of the Egyptian willow",[1] in addition to rose-water and scented pandanus water. Other drinks which Honigberger found to be popular were: buttermilk, lassī, thandāī, and "a vinegar syrup flavored with mint" (Honigberger 1852, p. 165).

---

[1]This is bedamushak or Salix caprea, according to Bhandari (1957, Vol. VII, pp. 92-93), and it is considered to have especially effective cooling properties.

Menpes noted in 1905 that "in the old days" the sherbet-seller's whole stock in trade was only a half-dozen bottles of traditional syrups, ". . . a drinking-vessel of copper, a pile of fragile pottery bowls, and a pitcher of clear water . . ." (Menpes 1905, p. 101). At the time of his writing, however, pre-bottled drinks of soda water, ginger ale, lemonade, etc. were more in evidence.

<u>IV, p. 158n</u>. Mrs. Meer has described the popularity of rose-water in Lucknow at about this same time. In addition to being added to water as a <u>sharbat</u>, this distallation served ". . . to cool the face and hands in very hot weather" (Meer 1832, Vol. I, p. 186).

<u>IV, p. 161, line 6</u>. The word <u>sādhu</u> is derived from the same Sanskrit root as <u>sādhanā</u> or "enlightenment", and for <u>sādhus</u> ". . . ganja-smoking is almost sacramental . . ." (Neill 1970, p. 23).

<u>IV, p. 172, par. 3</u>. An interesting research project in ethnomedicine would be a comparison of local Indian, Anglo-Indian, and British ideas of food and health interrelationships. Stephens reports, surprisingly enough, that as late as the 1930's among the British community in India

> Cholera for instance was still supposed to be induced--why, I never grasped--if one ate fresh fruit after dark. You could eat it at breakfast; but when the port went round at those evening parties, fresh fruit was never included with the dessert . . . . This was so even in a Delhi midwinter . . . (Stephens 1966, p. 106)

<u>IV, p. 172, line 16</u>. As one writer states,

> The melon is one of the most popular national fruits, and the amount that can be consumed by one man on a hot summer's day is something appalling. (Pennell 1912, p. 36)

In fact, although the canteloupe is, relative to the watermelon, a comparatively "hot" food, it has also long been popular. But more than one Anglo-Indian writer has commented on the total unpredictability of taste of these thirst-quenching fruits:

> There is no more uncertain fruit in the world than an Indian melon. You may cut into a hundred, and each one of them will taste faintly of rhubarb and magnesia. The hundred and first, outwardly the same, will be food for the gods. (Menpes 1905, pp. 98-99)

IV, p. 173, line 18. The prevailing Indian lack of concern about flies as real threats to health has been remarked by scores of foreign (and modern Indian) observers, and it does stand in contrast to the typical Western attitude. It is interesting to note, however, that in the distant era so nicely chronicled by Mrs. Meer, the European horror of flies may also have been based on something quite different from the microbial theory:

> If but one wing or leg of a fly is by any accident dropped into the food of an individual, and swallowed, the consequence is an immediate irritation of the stomach, answering the purpose of a powerful emetic. At meals the flies are a pest, which most people say they abhor, knowing the consequences of an unlucky admission into the stomach of the smallest particle of the insect. (Meer 1832, Vol. I, pp. 95-96)

IV, p. 175, line 35. While an analysis of folk song content and themes can no doubt provide much insight into the "hang-ups", the sensitive and sore points, of any given society and culture, they are much less reliable as descriptors of actual custom and practice. Bhojpuri folk songs are especially well known, thanks to the heroic work of Pandit Ram Naresh Tripathi, who during the 1926-1930 period roamed villages of eastern U. P. gathering over 10,000 songs (Shirreff 1936). He has published many of these, although I cannot presently cite the references, and others have been published by K. D. Upadhyaya (1949, 1955).

IV, p. 180. Data on the monthly incidence of nutritional disease given in the Indian Council of Medical Research's Report of Work Done in Nutrition in States 1955 are also of interest in this connection. But, since they were based on hospital statistics in the Panjab, they are not necessarily indicative of the situation in U. P. and Bihar--in fact, the figures conflict strikingly with those of Roy and Rao for West Bengal. A total of 8281 nutritional disease diagnoses were listed, mostly "nutritional anemia", "nutritional diarrhoea", and stomatitis. The enormous monthly differences in incidence were as follows:

January	311	July	1180
February	315	August	1163
March	496	September	1998
April	254	October	460
May	472	November	456
June	695	December	482

(Indian Council of Medical Research, 1956, p. 63)

IV, p. 180n. The sharp socioeconomic discontinuities in actual use of fruit, even when it might be thought to be locally available, are well illustrated by the Wisers' remark that oranges are regarded as great curiosities in the village of Karimpur (in Mainpuri District), even though they are grown only a few miles away (Wiser and Wiser 1967, p. 12).

IV, p. 184, par. 1. With respect to the quality of school hostel diets in India, C. N. Rao has recently published results of a survey questionnaire of 194 hostels. More than half provided excessive amounts of cereals or less than 3 oz. of pulses daily. More than a third included no leafy vegetables, and more than half no fruit. About 70% gave less than 10 g. of milk and milk products. In many institutions no breakfast was served (C. N. Rao 1966).

IV, p. 186n (1). Many fascinating aspects of the "cultural ecology" of cattle (including buffaloes) in India have recently been argued in a series of articles in Current Anthropology (Harris 1966, Bennett 1967, and Heston 1971). Among the items of interest reported there is the statement that, while buffalo milk usually commands a slightly higher price in the market, the production cost per pound is less than that of cow milk (Heston 1971, p. 193n). This writer points out that there is about a 2: 1 ratio of bullocks to cows in U. P. Exports or imports cannot account for the imbalance, and of the relatively few cattle slaughtered, probably less than 10% are females. Thus,

> It can be assumed that the low ratio is explained . . . by neglect of females and their premature death. . . . Uttar Pradesh, which generates the most rhetoric about cow protection . . . apparently neglects them most. (Heston 1971, p. 193)

IV, p. 186n (2). But the Wisers report that Karimpur shepherds add milk from their goats to that from village buffaloes which they sell in the city, because

> Goats' milk is satisfactory for the boiled-down milk used for making rich sweets . . . (Wiser and Wiser 1967, p. 187)

IV, p. 187, line 24. But Russell wrote in 1954 that the average Indian yearly per capita consumption of meat was 5 lb. (6 g. per day), and of fish only half that amount (Russell 1954, p. 329). This ratio seems somehow more believable to me than that cited by May, but I must leave the question unresolved.

IV, p. 173, line 18. The prevailing Indian lack of concern about flies as real threats to health has been remarked by scores of foreign (and modern Indian) observers, and it does stand in contrast to the typical Western attitude. It is interesting to note, however, that in the distant era so nicely chronicled by Mrs. Meer, the European horror of flies may also have been based on something quite different from the microbial theory:

> If but one wing or leg of a fly is by any accident dropped into the food of an individual, and swallowed, the consequence is an immediate irritation of the stomach, answering the purpose of a powerful emetic. At meals the flies are a pest, which most people say they abhor, knowing the consequences of an unlucky admission into the stomach of the smallest particle of the insect. (Meer 1832, Vol. I, pp. 95-96)

IV, p. 175, line 35. While an analysis of folk song content and themes can no doubt provide much insight into the "hang-ups", the sensitive and sore points, of any given society and culture, they are much less reliable as descriptors of actual custom and practice. Bhojpuri folk songs are especially well known, thanks to the heroic work of Pandit Ram Naresh Tripathi, who during the 1926-1930 period roamed villages of eastern U. P. gathering over 10,000 songs (Shirreff 1936). He has published many of these, although I cannot presently cite the references, and others have been published by K. D. Upadhyaya (1949, 1955).

IV, p. 180. Data on the monthly incidence of nutritional disease given in the Indian Council of Medical Research's Report of Work Done in Nutrition in States 1955 are also of interest in this connection. But, since they were based on hospital statistics in the Panjab, they are not necessarily indicative of the situation in U. P. and Bihar--in fact, the figures conflict strikingly with those of Roy and Rao for West Bengal. A total of 8281 nutritional disease diagnoses were listed, mostly "nutritional anemia", "nutritional diarrhoea", and stomatitis. The enormous monthly differences in incidence were as follows:

January	311	July	1180
February	315	August	1163
March	496	September	1998
April	254	October	460
May	472	November	456
June	695	December	482

(Indian Council of Medical Research, 1956, p. 63)

IV, p. 180n. The sharp socioeconomic discontinuities in actual use of fruit, even when it might be thought to be locally available, are well illustrated by the Wisers' remark that oranges are regarded as great curiosities in the village of Karimpur (in Mainpuri District), even though they are grown only a few miles away (Wiser and Wiser 1967, p. 12).

IV, p. 184, par. 1. With respect to the quality of school hostel diets in India, C. N. Rao has recently published results of a survey questionnaire of 194 hostels. More than half provided excessive amounts of cereals or less than 3 oz. of pulses daily. More than a third included no leafy vegetables, and more than half no fruit. About 70% gave less than 10 g. of milk and milk products. In many institutions no breakfast was served (C. N. Rao 1966).

IV, p. 186n (1). Many fascinating aspects of the "cultural ecology" of cattle (including buffaloes) in India have recently been argued in a series of articles in Current Anthropology (Harris 1966, Bennett 1967, and Heston 1971). Among the items of interest reported there is the statement that, while buffalo milk usually commands a slightly higher price in the market, the production cost per pound is less than that of cow milk (Heston 1971, p. 193n). This writer points out that there is about a 2: 1 ratio of bullocks to cows in U. P. Exports or imports cannot account for the imbalance, and of the relatively few cattle slaughtered, probably less than 10% are females. Thus,

> It can be assumed that the low ratio is explained . . . by neglect of females and their premature death. . . . Uttar Pradesh, which generates the most rhetoric about cow protection . . . apparently neglects them most. (Heston 1971, p. 193)

IV, p. 186n (2). But the Wisers report that Karimpur shepherds add milk from their goats to that from village buffaloes which they sell in the city, because

> Goats' milk is satisfactory for the boiled-down milk used for making rich sweets . . . (Wiser and Wiser 1967, p. 187)

IV, p. 187, line 24. But Russell wrote in 1954 that the average Indian yearly per capita consumption of meat was 5 lb. (6 g. per day), and of fish only half that amount (Russell 1954, p. 329). This ratio seems somehow more believable to me than that cited by May, but I must leave the question unresolved.

IV, p. 188, line 7. Kipling gives another reason for the Indian preference for goat meat:

> The native prefers kid before mutton, because the goat is a scrupulously clean feeder, while a hungry sheep will eat anything. (J. L. Kipling 1891, p. 102)

IV, p. 188, line 19. As indicated here, Indian meats have a low fat content, and the average Indian diet is also generally deficient in fats (see p. 192). Of course, lack of provender might amply explain why mutton and chicken obtained from an Indian butcher are so lean. However, this may not be the whole explanation, for Mrs. Meer, writing 140 years ago, makes a revealing observation which, while I am not certain, may still be valid:

> The fat of meat is never eaten by the Natives, who view our joints of meat with astonishment, bordering on disgust. . . . meat [is] exposed for sale in little lean morsels carefully separated from every vestige of fat or skin . . . (Meer 1832, Vol. I, p. 37)

IV, p. 189. How limited is the credence to be placed on findings of dietary surveys (in India as elsewhere) may be judged from the expert conclusion relative to the even more amenable conditions of the modern Western world, that

> For vitamins the dietary survey is not reliable. (Woolf 1954, p. 93)

Errors in survey results may derive from such sources as the following: the population sampling; the sampling period; the estimation of nutrients; and the estimating of foods eaten.

IV, p. 192. It is difficult to describe a villager's "typical" diet in North India, because of the many elements of variability that enter the picture. Yet, it is probably safe to say that at least 50% of the people on most days enjoy (?) a menu not very different from that described in 1929 by Banerji:

> Morning: 1 to 2 oz. gur or jaggery
>
> Midday: 8 oz. cereal grains (especially sorghum or millet), 2 oz. pulses, 2 oz. vegetables
>
> Evening: Same as for midday, with the addition of some milk in the better diets (Banerji 1929, p. 184)

For another version of a "typical" diet, see Dube (1955, p. 178).

V, p. 205, line 9. Most of the fevers among British residents in India at this time were in fact attributed to the effect of "bile",

> . . . excited perhaps from the accelerated circulation from the heat of the climate, or by relaxation from the same cause. (Tennant 1804, Vol. I, p. 77)

V, p. 206. Late in the 19th century, several fairly eminent British medical men, apparently including Sir Philip Manson, briefly espoused the idea that "true heat-stroke" (taken to be a condition where hyperpyrexia and loss of consciousness occurred, and distinguished from "sunstroke", believed to be caused by solar actinic rays) might be of microbial origin (Rogers 1908, p. 25). This was based on the belief that "heat-stroke" has a capricious distribution, not related to the temperature curve, and that its attacks occurred mostly at night, long after the diurnal temperature peak had passed. Rogers, in a significant study in India, demolished the hypothesis (see below).

With regard to therapy, an interesting exchange took place in the Journal of the Royal Army Medical Corps about the same time. Captain Foulds, in an article on "a little-known treatment for sunstroke", described his experiences at the army hospital at Jhansi, in southwestern U. P. His dramatic if not innovative procedure was to treat victims of "sunstroke" or acute heat hyperpyrexia by the prompt application of iced enemas. (He observed that, what with the scarcity of ice in the hospital, this was probably a more economical method of treatment than the conventional ice baths, or at least was an effective adjunct). He reported attending 15 cases, all of whom recovered, and

> . . . I consider the repeated enemas in each case saved the man's life. (Foulds 1906, p. 604)

Back came a spirited "Letter to the editor" the next year from two other junior medical officers who had served at the very same station, Jhansi. Their experience was entirely different as to the success of ice-water enemas:

> Nearly all the cases in which the enemata were given showed marked collapse after the administration. (Hull and Reed 1907, p. 341)

One case terminated fatally, with symptoms of severe dysentery, and

> . . . post-mortem the rectum was found to be partly gangrenous, the pathology being probably identical with the gangrene following frost bite. (Ibid., p. 341)

The writers recommended treatment by the intra-muscular injection of quinine. However, Fould's rather drastic form of cryotherapy apparently continued to retain adherents among British military medical men, for Willcox claimed that, in the nearly 8,000 cases (and 658 deaths) from heat hyperpyrexia in 1917 and 1918 among U. K. and Indian forces in the Middle East,

> Rectal injections of ice-cold water, or of ice-cold solution of bicarbonate of soda, 2 drachms to the pint, were beneficial. (Willcox 1920, p. 228)

V, p. 207n. According to Dr. Leslie (1971), Siddha is described in testimony before the Usman Committee, whose report was published in 1923 by the Madras State government. Dr. Taylor (1971) notes that Siddha today is greatly camouflaged by synthesis with Ayurvedic medicine. Although its earliest approach made much use of herbs, it soon came to use the herbs, as well as metals, mostly in the form of bhasms or ashes (Alexander 1969). Metal, for example, may be heated into ash and purified as many as 100 or more times, and the resulting ash is considered extremely potent (and is certainly extremely expensive!) Virtually all the published literature on Siddha is in Tamil, and a number of Siddha pharmaceutical books are listed in recent volumes of the Indian National Bibliography.

Pandian's Indian Village Folk (1898, pp. 118ff) contains an account of the local "physicians", and it is likely that there are many other such early ethnological or descriptive accounts which I have not seen. According to Pandian, these indigenous doctors attended no schools or colleges, but rather consult countless works of medicine written by 18 doctors of ancient times (whose names include some of the Siddha authorities listed in the Indian National Bibliography). Pandian reported that these local Siddha specialists made powders and pills from 9 kinds of poisons, used many herbal decoctions (of seeds, roots, leaves, bark, etc.), and also relied on copper, iron, gold, mercury, mica, pearl, and coral preparations. Their remedies were especially directed to improving and purifying the blood, according to Pandian, who asserts that the herbal treatments at least

> . . . are often very effective, and bring almost instant relief to the sufferer. (Pandian 1898, p. 119)

V, p. 208. Dr. C. A. Alexander has been kind enough to send me a pre-publication copy of his study, "Traditional healers in a region of Mysore", which is based on a study in a sub-district in Mysore with a population of 120,000. In this article is quantified, for the first time, a wealth of data pertaining to the nature and extent of indigenous medical practice in India. While these may not be entirely generalizable to my area of study (indigenous medicine always enjoyed rather more official patronage in Mysore than in U. P.), some of the findings are of interest. For example, the 120,000 people, living in 190 villages, in this area are served by only 6 "qualified" allopathic physicians, a ratio of one doctor per 20,000 population, very close to the national average. However, the extent to which such a statistic may be misleading is indicated by the fact that, in addition to the 6 M. D.'s, there are 30 full-time practitioners of heterodox medical systems (22 of whom are Ayurvedic vaidyas), and no fewer than 598 part-time practitioners. Thus,

> By including all practitioners and counting two part-time practitioners as one full-time, the ratio of physician to population reaches a spectacular 1: 360! (Alexander 1969, p. 6)

The part-time practitioners studied by Alexander make their living, of course, as farmers, tradesmen, priests, or craftsmen, and act as therapists only as a sideline. In fact, 65% of them do not even ask or receive any fees for their consultations. In most cases, each curer has some given specialty, such as rheumatism, snakebite, paralysis, skin disease, infantile or women's diseases, etc. Some 99% limit their remedies to herbs, poultices, powders, minerals, talismans and incantations. Not a single part-time practitioner was "registered", or recognized as qualified by Mysore's State Board for the practice of Ayurveda, Unani, or Homeopathy, and only 7 of the 30 full-time heterodox practitioners were so registered. Another interesting statistic is that, of the 628 non-M. D.'s in full or part-time medical practice in Mysore (over 90% of whom claimed to follow the Ayurvedic system), only two had undergone any formal schooling whatsoever in Ayurveda. But between 60% and 80% of them had been in practice at least 10 years, and stated that their curing skills and remedies were handed down to them by parents or grandparents.

Alexander calculated that 120,000 patient-visits annually are handled by the 30 full-time indigenous practitioners, as against 180,000 patient-visits by the 598 part-time therapists. He estimated that the total volume of patient-visits offered by the organized government health service of the area is about one-eighth as great as that generated by the indigenous medical systems.

V, p. 209, line 11. Allotting even 3% of government medical expenditures on indigenous medicine is considered a waste of money by the Western forces in India. This was Burridge's unsympathetic analogy:

> The financing of Unani and Ayurvedic Institutes by Governments in the hope of finding some soul of goodness in them is precisely on a par with the same Governments financing archery clubs to find out the possibilities of the bow and arrow in modern warfare. (Burridge 1926, pp. 41-42)

V, p. 212. There is an interesting sociological sidelight to the rivalry between Western medicine and Ayurveda in North India, in that the majority of leading practitioners of both are of Brahman caste. Indeed, very many belong to the widespread Kanya-Kubja sub-caste of Brahmans, whose contemporary life-ways are the subject of a recent monograph (Khare 1970). Thus, the professional disputation occurs, as it were, almost "within the family", with some members taking the road to modernity, while others persevere in olden ways. Khare notes that the divergence is strikingly manifested in photographs appearing in Kanya-Kubja, the caste journal, where the Brahmans with M. D.'s are suitably dressed in Western fashion, while the vaidyas and priests favor turban, kurtā, dhotī, etc. (Khare 1970, p. 89).

V, p. 214, line 1. Readers interested in anecdotal accounts of "primitive dietary wisdom" should refer to Price (1939). Among other examples, he mentions that the first Europeans settling in the Canadian Yukon regularly developed scurvy. Asked why his own people, the indigenous Indians, did not suffer from this sickness, an old Indian described their practice of removing from game animals "two small balls in the fat just above the kidney", which were equally divided among family members to eat. It is now known that this adrenal gland is the richest source of vitamin C that can be found in animal tissue (Price 1939, p. 75).

V, p. 215n. With respect to Indian differential attitudes towards sons and daughters, a recent survey by the Indian Institute of Public Opinion (1969) on attitudes towards family planning is most illuminating. When a large and representative sample were asked how many sons they considered ideal in a family, 17% said one and 63% two. For daughters, 63% preferred one and 23% two. As to the actual number of living children which they had, however, 16% had no sons, 23% one, 23% two, and 27% three or more. But 23% had no daughters, 25% one, 19% two, and 22% three or more (11% of the sample were unmarried).

V, p. 222. The leaves of mehădī or henna (Lawsonia inermis) were long in great demand in North India to make a dye used, among other purposes, to color the soles of the feet, and even the hands.

> . . . it is considered by them an indispensable article to their comfort, keeping those members cool and a great ornament to the person. (Meer 1832, Vol. II, p. 377)[1]

According to Bhandari, henna leaves are boiled with oil to make a cooling ointment to be applied in cases of headaches caused by excessive environmental heat (Bhandari 1951, Vol. VIII, p. 84).

V, p. 227n. Dérobert (1939, pp. 80-83) has described the typical syndromes of malaise or sickness associated with some of the European winds. Excessive positive ionization has been implicated in the hot dry khamsin or "Chamsin wind" in Israel (see Time, June 14, 1971, pp. 73-74).

V, p. 231, par. 2. In his study of indigenous medicine in Mysore (see pp. 504-505 above), Alexander found that only 5% of the part-time and only 20% of the full-time non-allopathic practitioners have some "remote but fair knowledge of the probable cause" of smallpox, cholera, tuberculosis, and typhoid fever. A large number of them (25% of the full-time heterodox doctors) thought that these diseases are caused by "heat, cold, or air" (Alexander 1969, p. 11).

V, p. 232. Unlike in the case of births, an enormous reduction in the annual flux of deaths (from 69% to 22%) has occurred in Uttar Pradesh since about 1860, the time reported by Hill (1888, p. 250). At that time the average monthly deviations from the average annual rate of registered deaths were about as follows:

---

[1]As noted on p. 247, mehădī leaves may be used to treat prickly heat. I am not sure if foot-painting applied to both men and women at the time of Mrs. Meer's account. Nowadays, at any rate, it is only the village women (and small children) who enjoy the colorful decoration of the feet, and they prefer a reddish-pink or reddish-violet color to the orange-hued henna. On only one occasion--as bridegroom in the marriage ceremony--is a man's feet painted (Planalp 1956, p. 494).

January	- 18.0%	July	- 21.1%
February	- 22.5%	August	- 3.0%
March	- 22.4%	September	+ 13.5%
April	- 4.1%	October	+ 46.9%
May	- 3.7%	November	+ 37.1%
June	- 9.0%	December	+ 6.0%

The greatest change has of course taken place in the reduction of deaths in October and November, and as a result of the attack on malaria by health authorities.

V, p. 233, par. 1. Relevant to the question of seasonal differences in health and morbidity, Sargent has reported that nutritional inadequacy and caloric deficiencies experimentally produce (in the U. S. A.) more intense and frequent minor symptoms (dizziness, weakness, nausea, and black-out spells) in winter than in summer (Sargent 1964, p. 24). And of course there is a virtually world-wide trend toward increasing winter and decreasing summer mortality, probably due to the greater ageing of the population. To my knowledge, however, Sargent's alleged relationship between malnutrition and a seasonal manifestation of symptoms of the kind he describes has not been noted in North India, where much more potent epidemiological factors are at play.

V, p. 235, par. 2. In relation to the likelihood that many North Indian shītāng cases are probably heat exhaustion, the comment of a modern medical investigator of experimental heat exhaustion is provocative:

> The subject's extremities are usually cold and clammy, and this is indeed a strange sensation to him for he is acutely aware, in most cases, of the sun's hot radiations. (Gold 1964, p. 402)

V, p. 237, par. 4. Some of the cultural bases of eye injuries in India have been especially noted by Mann. For example, there is a traditional Hindu rite that forms part of the midday prayer, in which the worshiper observes the sun through a small opening of the fingers. The priestly caste of Brahmans are of course those who are most faithful in the observance of these rites. However, solar retinitis caused by looking directly at the sun is not so much found among the skillful Brahmans, but rather among those non-Brahmans who are more zealous but less careful in their procedure of sun-gazing! (Mann 1966, p. 309)

V, p. 237. Another infirmity which, at least in the Tamil area of South India, seems to be attributed to heat, is piles:

> India being a country of extreme heat, piles are a common disease among those who constantly expose themselves to the sun, as the tillers of the soil must do. Those who live on alluvial soil and drink saltish water suffer from the painful sickness occasioned by internal or external piles. (Pandian 1898, pp. 122-123)

However, I have no evidence that this same idea obtains in North India.

V, p. 238

The word "mantra" has of course entered the English language. As Hindi words, however, the transcriptions given here are technically not quite correct. Instead of jantra, mantra and jantar, read jãtra, mãtra and jãtar (jantar or jãtar is Bhojpuri).

V, p. 240, par. 1. Many writers have mentioned the North Indian feeling of the head's special vulnerability to cold (see pp. 478-480), but an anecdote related by Sahgal is illustrative. Noticing a servant woman sitting outside the door of the house in the winter, someone remarked that she should feel cold. "No", answered a family member, "when she is really cold she puts a wad of cotton wool on her head and ties her ohrnī [scarf] around it". "Why on her head?" "That's where she feels coldest." (Sahgal 1962, p. 36)

V, p. 243, line 23. Although amaltās was mentioned by a couple of informants as a treatment of lū lagnā, I would now conclude that it is not the name of a drink, but rather of a plant (Cassia fistula) having powerful therapeutic effects, mainly as a purgative (Bhandari 1951, Vol. I, pp. 63-65). Constipation is, of course, a frequent concomitant of heatstroke.

V, p. 243n. Mrs. Meer's comments on massaging (although her term for it was "shampooing") are especially interesting:

> . . . it is a general indulgence with all classes, in India whatever may be their age or circumstances. The comfort derived from the pressure of the hands on the limbs, by a clever shampooer, is alone to be estimated by those who have experienced the benefits derived from this luxurious habit, in a climate where such indulgences are needed to assist in creating a free circulation of the blood, which is very seldom induced by exercise as in more Northern latitudes. (Meer 1832, Vol. I, pp. 83-84)

V, p. 247, line 8. The typical treatment of prickly heat by the peasantry in the Lucknow-Kanpur area by means of a plaster of multānī maṭṭī is mentioned by Mrs. Meer. She states that it is similar to fuller's earth. But

> . . . all this is but a temporary relief, for as soon as it is dry, the irritation and burning are as bad as ever. (Meer 1832, Vol. I, p. 114)

Mrs. Meer also reported that the Lucknow gentry treated their children (who were said "to suffer exceedingly from the irritation", with pounded sandal-wood, camphor, and rose-water (Ibid., p. 114). She pronounced bathing in rain-water her own personal choice of remedy!

V, p. 247, par. 2.

The chronicle of events whereby homeopathy became established in India, with its strongest roots in the Calcutta area, has been detailed by Sanyal (1964, pp. 181ff). John Martin Honigberger, a direct disciple of Hahnemann, first came to India in 1838,[1] practising in Lahore, and in the following year was credited with a successful treatment of Maharaja Ranjit Singh, leading to many court favors. Honigberger moved to Calcutta, where he practised until 1860 (see his autobiography: Honigberger 1852). By 1843 three homeopathic hospitals had been established in India, and the system of medicine generally found favor among Indians. Many governmental authorities were hostile, but some local officials here and there extended their special patronage, and there were additional cases of spectacular cures of important Indian personalities following the failure of orthodox and indigenous treatments. Yet, homeopathy seems to have been drifting into relative obscurity in mid-19th century India until it was suddenly embraced and popularized by Dr. Mahendra Lal Sarkar, a leading medical luminary of the time. He greatly advanced the cause of homeopathy despite the severe obloquy to which he was consigned by his professional colleagues.

V, p. 250n. I should have previously recognized that what lay behind "the popular belief in the salutary influence of prickly heat" was the old idea of "seasoring fluxes" (see p. 463). English sojourners in the tropics

---

[1]There is a contradiction implicit in this date, given by Sanyal, and the fact that Honigberger's own book, entitled Thirty-five Years in the East, was published in 1852. I am not at the moment able to explain the contradiction.

believed that only a minority of newcomers escaped having some sort of seasoning flux or "fever of acclimatization" (generally thought to be the first fever of unknown origin which happened to seize the newcomer). Such an escape, it was considered, might be due to "a favourable state of the body", or perhaps "a great regularity of living", but in some cases it was said to be owed to "the breaking out of the rash called Prickly Heat . . ." (Moseley 1787, quoted in Renbourn 1963, p. 195).

Some in India believed that prickly heat was itself a form of acclimatization fever, and an occurrence even to be desired for the longer-term maintenance of good health. Mrs. Meer observed in 1832 that prickly heat afflicted seriously only those persons who perspire excessively However, those who avoided prickly heat were not to be envied, for

> . . . then they suffer more severely in their constitution by many other painful attacks of fever, etc. So greatly is this rash esteemed the harbinger of good health, that they say in India, "the person so afflicted has received his life-lease for the year"; and wherever it does not make its appearance, a sort of apprehension is entertained of some latent illness. (Meer 1832, Vol. I, p. 114)

There was also a widespread belief in 19th century Anglo-India that

> . . . to repel the rash (or "turn it inwardly") by cold (e.g. large draughts of cold drinks, bathing in the sea, river or elsewhere) was regarded as particularly dangerous. (Renbourn 1965, p. 31)

V, p. 264. The following reference was inadvertently omitted:

Brass, Paul. 1971. "The politics of Ayurvedic education: a case study of revivalism and modernization in India", in Education and Politics (Lloyd I. Rudolph and Suzanne H. Rudolph, eds.) (in press)

VI, p. 267, line 18. This early hypothesis of Mills and Ogle continues to have currency, as seen in a recent statement:

> . . . heat exhaustion and heat stroke tend to be more common in the temperate zones than in the tropical zone. This can be explained in part on the basis of the increased metabolic rate which accompanies acclimatization to cold. During a period of sudden tropical inflow (heat wave) a decrease in the metabolic rate as well as other physiologic adjustments may not occur rapidly enough to maintain

thermal balance. The thermal regulating mechanisms may be taxed beyond their capacity so that they fail. Burch and DePasquale 1962, p. 179)

VI, p. 269, line 1. The mechanisms involved in the marked susceptibility of older persons to heat injury have been clarified by Gold. Most subjects over 40 lack the ability of younger persons to increase blood pressure by lowering the diastolic component (this lowering being a reflection of decreased peripheral resistance). If there is any increase at all in pulse pressure in an older man, it is usually at the expense of an elevated systolic pressure, an event that is physiologically deleterious (Gold 1960b, p. 1180).

VI, p. 269, line 34. For an incident of British military history involving severe heat casualties on the opposite side of the globe, see the article, "Heat ruled the day" in Military Medicine (1966, p. 677). Here is described Sir Henry Clinton's dispatch of July 5, 1778 to the Secretary of State for America, relating details of the battle of Monmouth that took place on June 28. The British left 249 dead, and Sir Henry reported:

> ". . . a large part of our dead were found to be without wound. They had died of heat and fatigue." (Military Medicine, 1966, p. 677)

VI, p. 270. Recently-published excerpts from the journal of a medical officer in the Mutiny describe the occurrence of at least 7 deaths from "Coup de Soleil" in Benares in early June. The writer's comments are interesting:

> "These cases occurred most frequently in parties moving and shortly after the first start, though they never moved off until the sun was well down, still the packing of luggage and arranging of hackries, with the excitement that every man feels at a first move in a new country leads to much exposure, and the forage cap when covered with a white turban, is a most imperfect protection from an Indian sun in June. Had the cap covers with capes protecting the back of the neck, temples and cheek which are now used, been sooner introduced I believe some valuable lives would have been saved." (Maclennan 1970, p. 208)

VI, p. 272. As to the total numbers of British troops stationed in India, Yeats-Brown gives the following approximate figures:

1857 (pre-Mutiny)	40,000
1863	65,000
1887	73,000
1903	77,000
1923	66,000
1939	43,000

Indian military forces, under British authority, during the same period ranged from a high of 232,000 in 1857 to a low of 139,000 in 1923 (Yeats-Brown 1945, p. 70).

In a chapter entitled "Sociology and Heatstroke: 1942 and '43", Ian Stephens, a news editor on the Calcutta Statesman, gives a fascinating (and quite probably rather overdrawn) picture of British military bureaucratic conservatism with respect to appropriate clothing and behavior in the heat. By his account, some younger British officers were well aware that Italian troops had suffered only light heat casualties in battle in the severe Ethiopian heat, by reason of discarding most clothing except a head covering. But military rigidity and over-dress, and failure to allow a period of acclimatization, were indicted by Stephens for causing an undue number of heat casualties among British troops in India in the summer of 1942. But exactly how many was difficult to determine:

> . . . even now, 23 years later, you'll find it bafflingly difficult to ascertain from the official histories what exactly the British Army "heat" casualties in India amounted to. Somehow the figures always seem blurred; they are for the men only not the officers, or else it's uncertain whether or not the other two Services are also mixed in. (Stephens 1966, p. 107)

Stephens quotes a heat casualty rate of 22.3 per thousand in 1942 in the R. A. F. alone, which if correct would suggest that the Army figure of 2000 is too low. However, the rate fell to 8.8 per thousand the next year, for which Stephens takes some credit (after a campaign of newspaper publicity giving advice to readers and criticizing the authorities), although it may have been more due to a cooler summer. The author himself was rather surprised to find, on a stopover with Glubb's Arab Legion in Aqaba in August, that the Arab headdress which provided only two thin layers of cotton between the head and the vertical sun, was much more comfortable and efficient than the solar topi. The drastic overthrow of old custom, such as wearing of the topi, in British India in the course of the War, is pointed up in an amusing episode:

> "Have you gone mad, Claude, where's your topi," demanded Lord Ismay, arriving at Delhi in March '47 after 15 years' absence and finding F.-M. Auchinleck at the airport to meet him using only a beret. (Stephens 1966, p. 106)

VI, p. 274, line 22. The idea expressed here, based on his own years of experience in southwestern Asia, that heatstroke often occurs many hours after a man has been exposed to heat-stressful conditions, is one that Willcox stated on many other occasions (e.g., Willcox 1920; remarks in Lee 1935). Perhaps his claims were tainted by association with the old and discredited microbial theory of heatstroke (see p. 503), but as an epidemiological fact, the matter of delayed onset of heatstroke would seem to merit more attention in medical research than it has been given.

VI, p. 274n. As Minard has noted, a frequent association between "rum and sun" and an epidemic form of "apoplexy" among laborers working in hot weather has been asserted by clinicians for at least 200 years past. Minard believes the physiological basis of the deleterious effect of alcohol on heat tolerance is probably complex, but that one factor is dehydration resulting from alcohol's diuretic qualities (Minard 1967a, p. 621).

VI, p. 276, par. 1. For an up-to-date review of recent U. S. and British military experience with heat casualties among acclimatized and non-acclimatized troops in various parts of the world, see Minard 1967b.

VI, p. 277. With considerable embarrassment, I have to admit having previously overlooked two very important and interesting studies of heatstroke epidemiology in North India, those of Rogers (1908) and of Hutchinson (1926). It seems most appropriate to discuss their findings here, even though both studies were concerned not with the indigenous civilian population, but rather with British army forces. As mentioned above, Rogers' classic study effectively laid the theoretical spectre of any microbial basis for acute heat injuries. His procedure was to tabulate, by region and by month, the number of heatstroke cases over a period of 3 years (1904-1906), then to compare these figures with meteorological data on temperature and humidity. The net result was to show, beyond all doubt, that any apparent capriciousness in heatstroke incidence observable when only dry bulb temperatures are considered, entirely disappears when the relative humidity, or moistness of the air, is taken into account. For our purposes here, Rogers' tabulations of heatstroke cases by month and by province are of greatest interest, and may be compared to the current Indian civilian monthly incidence (p. 283 above):

Heatstroke Cases in the British Army in India, 1904-1906[1]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Fatal (total)					7	31	17	4	3			
Non-fatal:												
Punjab					5	73	124	24	3			
U. P. & Bengal			3	2	11	57	22	17	10	1		
Central India				1	10	16	1					
Bombay			2	4	7	9	7	4				
Madras		1	1	1	2	3						
Total non-fatal		1	6	8	35	158	154	45	13	1		

The heatstroke rate or incidence cannot be estimated in the absence of statistics on the total number of troops at risk. But the author noted that, despite the especially large numbers of men stationed near the coastal cities of Bombay, Calcutta, and Madras, very few cases of heatstroke occurred there (Rogers 1908, p. 31).

Incidentally, Rogers also collected interesting information on the time of admission to the hospital of the nearly 500 cases of heatstroke, in view of allegations by the proponents of a microbial basis to the disorder that onset of hyperpyrexia often follows the day's peak temperature by several hours. He found that 74.2% of the cases were admitted between 12 noon and 8 p.m., 8% from 8 p.m. to midnight, 11.3% from midnight to 8 a.m., and 6.5% from 8 a.m. to noon (Ibid., p. 30)

In the other important epidemiological study, Hutchinson even more meticulously correlated the occurrences of 323 cases of heatstroke between 1916 and 1925 among British army garrisons in Allahabad, Cawnpore (Kanpur) and Benares (Varanasi). Again, no figures are provided as to the total numbers of men at risk. The author also cautions that these statistics do not differentiate between heatstroke and heat exhaustion, since hospital differentiation of the two syndromes commenced only in 1921.

[1]Source: Rogers 1908, p. 26. The total number of fatal cases was 62, and of non-fatal cases was 423.

The monthly breakdown of heatstroke cases provides the most dramatic focus on the month of June of any of the various reports that have been mentioned: April: 1; May: 29; June: 197; and July: 4 (Hutchinson 1926, p. 74). Hutchinson's analysis was largely directed toward enumerating the total percentages of cases occurring on days having: (1) various maximum temperatures; (2) various minimum night temperatures; and (3) various degrees of relative humidity, as measured at 8 a.m. on the day of occurrence. The findings, in terms of percentages of cases occurring, were:

(1) 45% over 114° F., 42% at 110° - 114° F., 8% at 108° - 110° F., and 5% under 108° F.

(2) 48% on days having a 24-hour minimum temperature of more than 90° F., 31% at 85° - 90° F., 19% at 80° - 85° F., and 2° under 80° F.[1]

(3) 8% with a R. H. over 60%, 26% at 40 - 60% R. H., 40% at 30 - 40% R. H., 40% at 20 - 30% R. H., and 26% under 20% R. H.

He also utilized mean temperatures and wet bulb temperatures, and attempted without much success to give weight to the effect of "heat wave duration". However, Hutchinson's analysis failed to put these factors together to provide some total or combined figure of "effective temperature".

One of the most interesting results of Hutchinson's study, and one which he found frankly inexplicable, was a heatstroke incidence in Kanpur that was only about one-fourth as high as that in the other two locations (Ibid., p. 54). However, he admitted having no information pertaining to a number of critical factors, which might possibly have been different among the three stations: work or energy expenditure, food and drink, and the existence of any infections.

> All that can be said is that constipation was a common precursor and that malaria was not evident as a predisposing cause or complicating factor. (Hutchinson 1926, p. 56)

The great importance of heat waves in the production of "epidemic heatstroke" emerged with clarity from this study, for only 27 cases occurred in the 7 coolest years, compared with 205 cases in the 3 hottest years. In fact, 113 cases were produced by a single 62-day "heat wave" (defined as a period in which the average maximum temperature was over 108° F. and the mean temperature was over 93° F.) in 1923. Noteworthy among the changes in

---

[1]The highest 24-hour minimum temperature recorded, incidentally, was 97.3° F. (Hutchinson 1926, p. 55).

military regimen instituted following this study was the provision of the main protein meal in the evening rather than, as was the custom, having it at about the hottest time of the day (Hutchinson 1926, p. 70).

VI, p. 285, par. 1. As to the epidemiology of prickly heat in 19th century India, among both Indians and British residents, Mrs. Brittan described it as almost universal. She lamented

> . . . the terrible prickly heat with which almost every one is troubled at the commencement of the rainy season . . . There is scarcely one person--old or young, rich or poor--but what is troubled to a greater or less degree with it. (Brittan 1880, pp. 51-52)

Since this rash is found ". . . mostly prevailing . . . wherever the clothes screen the body from the power of the air" (Meer 1832, Vol. I, p. 113), it seems quite probable that much of the difficulty, among the Europeans at least, arose from the cult of the flannel binder or cholera belt (see p. 465), the wearing of which could ". . . be guaranteed to produce a nice band of prickly heat . . ." (Renbourn 1957, p. 222). The only surcease from prickly heat came with the monsoon rains (Edwardes 1969, p. 156).

VI, p. 296. It is indeed a measure of the great disparity in health and in economic conditions between India and the Western countries that so many medical authorities in the former country would feel constrained to select "poverty" (relative poverty, that is, among a population that is generally impoverished) and malnutrition as leading selective factors in heatstroke occurrence. In the West, on the other hand, hardly any expert would disagree with Leithead as to the two salient characteristics of victims of the most severe kind of heat injury:

> There is no doubt that in civilians exposed to heat waves, heat stroke is more common in the elderly and in the obese. (Leithead 1967, p. 742)

VI, p. 297, line 11. In reference to "heat islands", see Chandler's recent bibliography on urban climate (Chandler 1970).

VI, p. 302. The best-reported investigation that I have found in recent medical literature of heat disorder incidence on the Asian continent is that of Salem (1966), in relation to Kuwait. The results are only partly generalizable to North India, but are exceedingly interesting. In 1960, 135 heat patients (including 47 heatstroke) were admitted to the hospital, of whom 6 died, while in 1965 there were only 66 admissions (2 heatstroke) and no fatalities. External environmental factors were virtually identical during the summer months of the two years. But it is the analysis of this epidemiology that is most provocative. First, there were no fatalities and few admissions among native Kuwaiti citizens. The author rather simplistically holds that

> . . . this is due to the inborn acclimatization process of the native inhabitants. (Salem 1966, p. 398)

However, as his description goes on to make clear, almost all the cases arose among unskilled laborers who had entered the country illegally, attracted by opportunities to earn money. These poor immigrants lived in crowded, filthy houses, dressed "unsuitably", according to the author, and due to their basic insecurity worked more strenuously on their jobs than did the native Kuwaitis. (Probably, this last is the factor which most contributed to their collapse in the heat.) The large reduction in heat cases by 1965 might seem to document an improvement in prevention and therapy; however, Salem notes candidly that the principal significant change was the government's expulsion of most of the illegal immigrants in the interim. To some degree, this epidemiological pattern of concentrated heatstroke incidence among urban immigrant unskilled laborers no doubt obtains in the large cities of northern India.

<u>VI, p. 302n</u>. Results of a study of 50 infantile heat illness admissions to the outpatient department of the Children's Welfare Hospital in Baghdad, Iraq further confirm this surmise. Iraqi mothers do customarily give adequate fluids to their children, and heat illness here developed only during the exacerbation of a severe heat wave, or following prolonged exposure, when the mother failed to provide the necessary extra amounts of liquid (Taj-eldin and Falaki 1968, p. 103). Vomiting occurred in 54% of the cases. (This response does not often occur in adults.)

Particularly useful for comparative purposes is the analysis by Danks, Webb and Allen (1962) of the 47 infants and young children admitted to hospitals in Melbourne, Australia during a week-long heat wave in January, 1959. Almost all the admissions occurred on the second or third day of a period of three days when maximum daily dry bulb temperatures were from about 104° - 109° F. (with about 15% R. H.) and minimum night temperatures were 75° - 90° F. Most of the victims lived in poor housing conditions, with house interior temperatures even higher than official readings. There were 6 deaths among the 47 infants, and the authors noted that a factor of prime importance so far as survival was concerned was distance from the hospital. The difference between a journey of 1/2 hour and 1 1/2 hour may well have been crucial in several cases (Ibid., p. 290). Vomiting, in the late stage of heatstroke, especially occurred where mothers continued to give the babies milk instead of water. Only in the smallest babies was hyperpyrexia more frequent than severe dehydration, a finding which supports the medical view that effective thermoregulation, including sweating, are absent in the newborn. They conclude:

> The special susceptibility of those aged 3 to 9 months may be related to the tendency of babies of this age to refuse feeding when they are in discomfort. (Danks, Webb, and Allen 1962, p. 292)

Incidentally, the authors commented on the preponderance of males to females (29 to 18) in the series, but were unable to account for it.

VI, p. 303, line 26. According to a decision taken by the Bihar State Cabinet on May 26, 1971, the capital city of Bihar will henceforth be known as Pataliputra, not as Patna. Pataliputra was the ancient capital of Magadha and the Mauryan empire (India News, June 4, 1971, p. 2). I also note that the most recent edition of Spate and Learmonth's geography of India duly lends its authority to the new spelling for Lucknow: "Lakhnau" (Spate and Learmonth 1967, p. 2).

VI, p. 305n. Newcombe reported in 1905 that horses are to be seen in Bombay and in Calcutta with hats on their heads. However, this custom was rarely met with in North India, despite the fact that horses suffer from heatstroke and other effects of heat (Newcombe 1905, p. 76).

VI, p. 308, line 1. Presumably the heroic Patna beggar who sat exposed through the heat wave was adequately supplied with water. In the pursuit of religious austerities this is not always the case--for example, at an event occurring annually in Lucknow on a date of the lunar calendar which falls during the hottest season. Devotees or persons who have made a vow, make a slow, length-measuring pilgrimage requiring many hours along an asphalt-paved road. The pilgrim stretches full length on his face, places a stone on the ground in front of him, then rises, stands at the stone, prostrates himself, and repeats the action. Dressed only in a loin-cloth, he is obligated to fast from all food and drink. However, some water replacement would seem to be a physiological necessity, and one observer has noted that friends and relatives of the devotees often follow along and occasionally provide a surreptitious sip of water (Rutledge 1962, p. 173).

This may be winked at in accordance with the sort of Hindu casuistry referred to above (p. 155):

> Hinduism is elastic enough to ignore its own rules when they are practically unworkable . . . (Crooke 1906, p. 229)

However, Muslim strictures are likely to be more inflexible, and Mrs. Meer states that in Lucknow 150 years ago, whenever the month-long fast of Ramadan (see pp. 98, 486) fell in the hot summer season, it was not uncommonly seen that the faithful would accept death from heat and thirst rather than break the strict rule forbidding any liquid or solid intake whatsoever from sunrise to sunset (Meer 1832, Vol. II, p. 187). Such victims tended to be children, who were enduring their first fast.

VI p. 315, line 1.

> In the Hindu village society social sanctions are imposed both for failure to observe funeral rites, and also for failure to observe rites of marriage and eating . . . (Clark *et al*. 1941, p. 52)

VI, p. 316, line 17. In eastern U. P. there are two of the year's 27 *nakshatras* or 13-day asterisms during which farmers especially urgently require rain. One of these is Adra (about June 19 to July 2) and the other is Hast or Hatia (September 24 to October 7). In fact, there is a popular couplet to the effect that "If it rains in Adra, and also rains in Hast, then no matter how much tax the King levies the farmer will still be happy" (District Gazetteers, Vol. 33, *Azamgarh*, p. 22)

VI, p. 318, par. 1. The greasing of palms is an old and established procedure in India. As a Western psychologist and visitor to India put it:

> The centuries-old habit of soliciting patronage from his oriental oppressors has become ingrained in the Indian and hence to enlist family influence, to intrigue and to bribe, if not the master, then his servants, are considered legitimate. (Davy 1946, p. 220)

Seldom has the typical picture of the Indian peasant's fear of exploitation by officials and townsmen, together with consequential attitudes of distrust and suspicion, been more finely limned than in the Wisers' *Behind Mud Walls 1930-1960*. Respecting new Anti-corruption offices, then, the Karimpur villagers would quickly agree that

> "Every new office means to us just one more person to be feared and ingratiated." (Wiser and Wiser 1967, p. 127)

VI, p. 320. Perhaps it should have been specified here that all the Effective Temperatures relating to comfort that are cited assume a sedentary or inactive physical status. The figure of 70° F. ET which may be applicable to the average American at rest, falls to about 60 if he is engaged in moderately heavy work, and may be as low as 50 for very heavy work, because of metabolic heat production (Poulton 1970, p. 145).

The reader should consult Folk's excellent mongraph which very clearly shows the range and the distribution of comfort areas for temperate-acclimatized and tropical-acclimatized populations (Folk 1966, p. 155). One distinct feature is the marked skewing of distribution in the case of the former group, but not the latter. In other words, tropical acclimatization tends to reduce the range of individual differences in comfort response.

VI, p. 324, par. 1. There is a mistaken implication in the text here of slight female superiority over males in heat tolerance which requires correction. The higher skin temperature of women may well work to their benefit in terms of mechanical heat transfer when ambient temperatures are below body temperature. Additionally, in low or moderate heat stress a higher skin temperature may favor insensible perspiration, ensuring the maximum amount of evaporation with the minimum waste of electrolytes. Thus, in one study (Stolwijk 1969) men reported discomfort in the heat earlier and with higher estimates than women.

However, the best physiological evidence seems clearly to point in the opposite direction in conditions of severe heat stress, or in any heat where large increments of energy expenditure are involved. A higher body temperature is needed in women than in men to produce an equivalent sweat output, and the sweat glands in women also have a lower maximum output. As a result, women's body temperature rises much higher, presenting a lower thermal gradient for the removal of metabolic heat, a marked disadvantage in conditions where the ambient temperature is above body temperature. In addition, females have less reserve capacity to move blood to the skin (Hertig and Sargent 1963, p. 813).

> Women are obviously less tolerant than men to heat. The withdrawal frequency of men in a dry climate of 61° C. [141.8° F.] is about the same as that of women at the temperature of 53° C. [127.4° F.]. (Löfstedt 1966, p. 63)

In fact,

> Above the equilibrium limit, the women seem to lose all control over their body temperature, which starts to rise so quickly that there is only a narrow limit in time before the onset of a heat collapse. (ibid., p. 63)

On the other hand, there is no reason to believe both sexes cannot tolerate the same amount of physiological strain, and the sex differences in heat tolerance described above are probably greater for very short exposures (under 4 hr.) than for longer periods. Workers at the University of Illinois have consistently found that men's sweat glands can activate and maintain a significantly higher flow rate, especially in high heat, and perhaps above all in dry heat, than can those of women (Morimoto _et al_. 1967; Weinman et al. 1967). Women must activate more sweat glands at lower heat stresses in order to achieve evaporative thermoregulation. What are described as "striking" sex differences in blood pressure changes are also reported, mainly in the fact that the diastolic blood pressure decreases much more with continued heat stress among men than among women (Morimoto _et al_. 1967, p. 532). However, as previously found by Hardy and Du Bois, women, unlike men, show a significant decrease in rectal temperature (Weinman _et al_. 1967, p. 538)

Yet, both men and women appear to be able to achieve similar increments of overall heat acclimatization, suggesting that there may be a number of different "configurations of component regulatory processes" which produce a functionally similar end-result. In fact, a serious defect in the scientific literature is said to be that most of the experimental studies of sex differences in heat tolerance have been made in unacclimatized rather than acclimatized subjects (Newman 1971).

VII, p. 334, par. 1. An interesting hypothesis relative to climatic effects on human physiology and psychomotor patterns was enunciated many years ago in the pages of _North Indian Notes and Queries_. The idea originated in observations that Indians (and, perhaps, most Oriental peoples) used their bodies and muscles in a different manner than did Europeans in the performance of many actions--e.g., in kicking, in swimming, in whistling, in beckoning, in plucking, in conveying food to the mouth, in digging, in sawing, in planing, in shooting marbles, etc. Moreover, it was concluded that in all these different actions, there was one underlying principle. This was the fact that Westerners use extensor muscles, while Asians use flexor muscles. The connection of this psychomotor pattern with climate was made by William Cockburn:

> . . . heat and the resultant langour [sic] is the reason why the flexors are more used than the extensors . . . . man in a warm climate requires to be slow in his movements . . . . The extensors . . . can be acted upon with greater quickness than the flexors, and thus their use was increased in cold climates . . . (W. Cockburn 1893-1894, p. 116)

Earlier, Mr. Cockburn had stated:

> . . . though the flexors are invariably bulky and capable of greater force, they are not so tough as the extensors . . . and they cannot be worked so quickly. (Cockburn 1892-1893, p. 176)

His conclusion was that, in general, a warm tropical climate creates in its inhabitants a pervasive languor, and

> Langour (sic!) will be found to be the cause of many differences in morals, behaviour, style of speech, way of thinking, and of construing the behaviour of others . . . (Cockburn 1893-1894, p. 116)

To the present-day anthropologist, this theory is likely to sound quaint and simplistic.[1] I am unable to say if the alleged differences in toughness and quickness between the two sets of muscles in man has any basis in fact. It strikes me also that the asserted correlation between predominantly-flexor or predominantly-extensor muscle use with tropical and cold-climate peoples (or Orientals and Europeans), respectively, should be based on a systematic and complete inventory of all the discrete episodes of muscle use, rather than on a selective one such as that of Cockburn (even though his list is indeed a lengthy and varied one). In this way, more statistical validity could perhaps be established--although, even if it were, its principal basis might well be found to reside not so much in climate as in culture, or in the traditional patterns of sitting or squatting on the ground rather than sitting on chairs. At any rate, the whole matter would seem to constitute an interesting question for physical anthropologists to study, and to my knowledge no one in this field has commented on it.

<u>VII, p. 337, line 23</u>. In reference to alleged tropical hyperglycemia, Sundstroem long ago pointed out that some grave error must have entered into the research procedures of the work (done many years ago by Langen) which produced these findings. Later and more careful investigations refuted the claim and tended to show that blood sugar is, if anything, at lower levels in the tropics (Sundstroem 1927, p. 341).

---

[1]Dr. R. W. Newman notes, for example, that whether a limb movement is outward or inward, both sets of muscles--flexors and extensors--come into play in its enactment. However, Cockburn was also aware of this fact--his emphasis was upon which set of muscles is primarily utilized in exerting the force.

VII, p. 340. The pages of thoughtful Indian journals[1] are occasionally enlivened by disputes focusing on questions of this kind. Thus, recently in Science and Culture a writer ostensibly took up cudgels against another eminent man who had argued that "otherworldly attitudes" inhibit scientific research in India. But in the course of his comments he too admitted that

> . . . a general sluggishness in the sheer motor movement of a large section of the people involved in scientific activities stands out in contrast to the observable habits of the Americans. (Sinha 1967, p. 326)

(Far from invoking any climatic basis for this lassitude, however, he attributed it to a long-standing excess of unskilled labor in India, producing the tradition of a division of work which might be done more easily and efficiently by a single person into segments that employ many people while making all of them lethargic.)

VII, p. 342, line 23. The Wisers have provided some empathetic words of explanation for villagers' continuing to live in crowded compact villages, and in the conservative, dilapidated houses described by Chaudhuri:

> You cannot know unless you are a villager, how everyone threatens us and takes from us. (Wiser and Wiser 1967, p. 127)

---

[1] Of course, by the sophisticated (and arrogant?), "ultra-scientific" and hyper-intellectual standards of evaluation that the Western world (especially, var. academia americana) has accepted, too often without any soul-searching examination of their real meaning and validity,

> Much of the research which is carried out [by Indians] is epiphenomenal to world science; most of it appears in Indian scientific journals which are not much noticed outside of India and even in India it is less regarded than foreign science. (Shils 1970, pp. 190-191)

Yet, for all the occasional naivete, crudity, sophistry and other intellectual shortcomings apparent in Indian scientific and scholarly journals, there is a quality of holistic and profound inquiry therein not so often found elsewhere, and without which the world would be far poorer. Relatively fewer Indian scholars, scientists and thinkers have ". . . confused knowledge with what can be expressed in words or numbers as against what can be felt and sensed", and there is a more basic appreciation of the epistemologically critical fact that ". . . what a man senses and feels in his very bones underlies how he thinks and behaves" (Watts 1970, p. 302).

> The fear of dacoits--robber gangs--or cattle thieves who come at night, hangs over every household. And there is certainly a greater feeling of security in knowing that just inside every front door, up and down the lane, there are neighbors within call. (Wiser and Wiser 1967, pp. 146-147)

> . . . our fathers built their walls strong enough to shut out the enemy, and made them of earth so that they might be inconspicuous. . . . now they are better protection if instead of being strong they are allowed to become dilapidated. Dilapidation makes it harder for the covetous visitor to tell who is actually poorer and who simulates poverty. (*Ibid.*, p. 120)

VII, p. 342n. Is it possible that air conditioning has the potential to provoke a revolution as great as that claimed for the chimney? Stamp points to the example of Hong Kong, which suffers from a very sultry and hot summer climate:

> . . . it is not perhaps fully realized that the artificial climate now commonly used in the larger factories of Hong Kong have made possible the spectacular economic development of the past decade. (Stamp 1964, p. 50)

He sees even greater promise in the world's hot deserts, whose climate --given the adjunct of air conditioning--would be ideal for retired people, and could easily settle millions of them. But the advocates of air conditioning sometimes indulge in entirely reckless flights of fancy, as when a number of Pakistani university vice-chancellors proposed the building of a completely air-conditioned university, outside of which, it was envisioned, the students would scarcely stir for 9 or 10 months of the year (*Ibid.*, p. 52). A foremost expert on human ecology has opposed the indiscriminate increase of air conditioning in the tropics on the grounds of social justice (Lee 1950), while Ladell has produced the simple hard statistics relative to how much power would be required to dehumidify and cool even one room in every family's house, and finds the cost prohibitive:

> Under-developed countries have better uses for their limited supplies of power. . . . Man was born to a hot-wet climate and can readapt to it . . . (Ladell 1964, p. 652)

VII, p. 348, par. 3. My survey of the literature, although far from exhaustive, has failed to detect much evidence or discussion of possible relationships between malnutrition and heat injuries. In one study carried out in Uganda with the specific aim of determining any effects of nutritional adequacy on sweating mechanisms, the conclusion was clearcut that neither volume nor composition of sweat were affected (McCance, Rutishauser, and Knight 1968, p. 663). Of course, no one would be willing to assert that pronounced malnutrition is optimal for health in the heat, but it does seem likely that even a very slight degree of overnutrition or obesity increases the risk of heat injuries (especially in the elderly, and in those who work strenuously) more than will a slight degree of undernutrition. The famous ecological rules of Allen and Bergmann state that the limb-weight ratio, or linearity in body form, is positively associated with environmental temperature in any given species (see Baker 1958 and Barnicot 1959, p. 119), and in man is negatively correlated with body temperature (Schreider 1957). Again, a lowered BMR is a characteristic feature of successful tropical adaptation and heat acclimatization. And the classic semi-starvation studies of Keys and his colleagues produced declines in BMR on the order of 40% (Grande 1964, p. 915).

VII, p. 349. There is one possible relationship between tropical conditions and diet that has not previously been mentioned in this report, although it has sometimes been alleged by observers (but not, to my knowledge, by professional nutritionists). The idea is put in the form of a question by an eminent geographer:

> What is the significance of the very widespread use of hot or highly spiced foods in the tropics--from the curries of India to the chile-con-carne of tropical America? (Stamp 1964, p. 39)

Thus, there was a time-honored saying among European colonials in West Africa: "You can't know fever while good peppers flame within you", and it has been claimed that the 19th century traders in that part of the world who lived the longest were those who ate native foods (White 1957, p. 79).[1] Virginia Hunt has also noted a craving for highly spiced food among Europeans who have lived for some time in the tropics (Hunt 1942, p. 23).

---

[1]Some of the early Portuguese doctors in India toyed for a time with the interesting idea that many illnesses of Europeans in India might be cured by a process of ". . . changing of the European blood in their patients' bodies into natives', by a diet consisting exclusively of the products of the country" (North Indian Notes and Queries 1891-1892, p. 107).

Dr. Stamp provides a "most likely explanation" for the relationship he alleges: the need to stimulate the digestive juices from a tropical lethargy. Hunt also makes a guess, and nothing more than this, that the craving for spiced food may result from the bodily depletion of potassium, sodium, chloride, etc. as a result of sweating and of mineral deficiencies in tropical diets (Hunt 1942, p. 23). However, I am not sure to what extent there has been demonstrated a close correlation in fact between the categories of "highly spiced foods" and "tropics". Perhaps the correlation, if there is one, of hot spices is rather with nutritionally poor diets which for caloric sufficiency must rely on large amounts of such bland starchy staples as rice, cassava, or maize. Certainly, Stamp errs in implying that chile con carne is a tropical American dish, since it is notoriously of North Mexican-Texan provenience. The subject is presumably greatly amenable to quantification using the materials at Human Relations Area Files. In fact, this organization has prepared exhaustive lists of foods and foodstuffs used by hundreds of the world's cultures (see HRAF 1964), but so far as I am aware no investigator has utilized these to seek statistical correlations of "hotness" or "spiciness" with climatic, economic or other variables.

In India, "hot" or "peppery" food seems to be at its maximum in the Tamil-speaking area of South India, but it was the subjective impression of the Workmans (p. 497 above) that, over a large part of the country,

> The chief spice used for seasoning is red pepper, which is used with such an unsparing hand that food is often uneatable. (Workman and Workman 1904, p. 69)[1]

The Madras region is of course an area of nearly year-round humid heat, greatly comparable to equatorial and coastal West Africa. However, it is also one of the most, if not the most, malnourished areas in India, where red peppers are relied upon to supply much of the vitamin C and vitamin A in the diet, and where there is little in the way of fruits and vegetables to leaven the bulky and monotonous dietary mainstay, boiled rice.

---

[1] From my own experiences in sampling typical indigenous meals in eastern U. P., I would conclude that the spicing is rather erratic. At one time, or in one family, it may be rather sparing of red peppers, while at another time or place it is fiery in the extreme. I believe the ideal recommendations of villagers regarding seasonal uses of "peppery" spices, as described above (p. 173), are followed to some extent in practice. But I retain enough memories of mouth-burnings during May and June village marriage feasts to know that red peppers are not always excluded in the hot season.

VII, p. 350, par. 2. The eminent geographer L. Dudley Stamp, while applauding the passing of the solar topi, still goes to bat for the old Anglo-Indian flannel cummerbund, whose chief function was of course to combat chilling effects on the abdomen:

> In tropical climates, especially those subject to sudden changes, such as heavy rainstorms, there is ample evidence that almost any form of clothing increases liability to illnesses stemming from drying of damp clothes, notably pneumonia. Any European in the tropics soon becomes aware of the dangers of a chill after exercise, with falling temperatures after sundown, and especially from that evil instrument of civilization, the electric fan. In particular, many stomach troubles are to be traced accordingly. (Stamp 1964, p. 39)

VII, p. 351, line 11. Kipling's words here could hardly find a more exact echo than in a statement emanating from present-day physiologists describing the testing of men in hot climatic chambers:

> If we return the man to a thermally neutral environment and begin to cool the room, certain responses which curtail heat loss occur at surprisingly high temperatures (we have seen nude men complain of chilliness after two hours at 83° F.) (Buskirk and Bass 1960, pp. 314-315)

VII, p. 353, par. 1. Much may be made of the effects, psychic and physiological, of the direct, unbuffered interface with Nature enjoyed (or imposed upon) the rural and the poor in India. But few human biologists have made careful scientific studies aiming to show possible effects of direct exposure to meteorological factors. One such is Henrotte (1966), who compared higher income and very poor samples in Madras through cool, hot and rainy seasons. He found significant seasonal variations in plasma K and Na in both groups, but in urinary 17-ketosteroids only among the poor. He attributed this to changes in adrenal cortex activity resulting from wind and rain on the one hand, and unventilated summer heat on the other hand. However, the conclusion is open to some question because of significant differences in food intake between the two groups.

VII, p. 354, par. 1. The author has long suspected that the weakest link in the chain of assumptions and logic underlying the whole vast edifice of Western science only comes into focus by a sensitive and sympathetic investigation into the difficult area of extraordinary or "supernormal" psycho-physiological phenomena. There are subtle but significant interrelationships and inter-determinants here which deserve close scrutiny by anyone sincerely concerned with the meaning of life, with the heuristic but unreal schism of the soul between "the scientist as scientist" and "the scientist as human being", and the equally artificial and untenable division between "scientific truth" and "ultimate or religious truth". The present work is not a suitable vehicle to present ideas on the operative mechanisms in developing a more adequate and realistic scientific method and philosophical grounding, but further thoughts on the matter are being prepared (under title of "Another View") by the author for the benefit of interested readers, upon request.

A, p. 363, line 30. There is a very ancient Near Eastern idea that semen arises in the head, and this is also stated in the Koran (Gordon 1959, p. 94).

A, p. 367, par. 2. Although the fundamental principles of Ayurveda have remained unchanged since the early period here described, it is possible that empirical improvements in the system of medicine resulted from the kind of experimental procedures described by Sanyal (1964, pp. 75ff). He notes that during the reign of Ballal Sen (12th century) in Bengal, there were four types of capital punishment: (1) live burial; (2) burning; (3) by spikes; and (4) sacrifice, apparently by decapitation, in front of the goddess Kali. (This last procedure was limited to prisoners of noble rank).

However, it became customary for the medical specialists of the time to obtain from among those destined for deaths by either the second or third categories listed above, men of good health and physique for experimentation. These human guinea-pigs were known as "Romthas", and the word was branded on their foreheads. Drugs were tested on these subjects, they were bitten by poisonous snakes, deep wounds were produced in their bodies, or other experimental operations were performed. Those who proved sufficiently cooperative (and who survived) might eventually be pardoned of their crimes and gain freedom.

A, p. 373, line 13. Virya, according to Sanyal, derives from the influence of the Sun (hot)or Moon (cold) (Sanyal 1964, p. 82).

A, p. 375, par. 2. In actual everyday village practice, pulse-feeling has long been the standard method of Ayurvedic diagnosis (Planalp 1956, p. 711). And among the strictly secluded Muslim and upper-caste Hindu families in North India, the vaidya might even have to obtain his pulse-reading and tongue-inspection through slits in a curtain, if not even more indirectly, through a servant or other intermediary (Brittan 1880, p. 74). Many a Western-trained doctor working in India has remarked on the patient's surprise, if not scorn, when the doctor queries him about various of his symptoms. "You have felt my pulse; you should know what is wrong" is the typical reply or attitude (see, for example, Munson 1913, p. 100). It is this expectation that the pulse can really "tell all", if the doctor is skillful enough to read it, more than any impulse to levity or deception, which underlay the experience of some of the early physicians coming to India, as described by Crooke:

> The difficulties of these early doctors, particularly in treating native ladies, were great. They were allowed only to feel a hand thrust out through a hole in a curtain, and it was a common trick, in order to test the doctor's skill, to make a healthy slave-girl take the place of her mistress. (Crooke 1906, p. 322)

A, p. 376n. Instead of mantra, read mãtra. These exorcists or faith-healers, and those referred to on p. 226 above, have been described by the Wisers (1967, pp. 34ff, 176ff) as bhagats, apparently the term current in the Karimpur village area of Mainpuri District in western U. P. But in Madhopur village (Jaunpur District, eastern U. P.) a bhagat is not necessarily a curer. The word here connotes "devotee" and especially implies that the individual is a strict vegetarian-on-principle (see p. 183 above and Planalp 1956, p. 919). In the Madhopur area those who cure through the force of mãtras, especially if they are rather respectable men of higher caste, may be rather formally described as mãtravidhs. If they are of lower caste, and especially if any form of trance state or "spirit possession" (either possession of the curer by his tutelary deity, or possession of the patient by an intrusive supernatural entity), they may be described as ojhās (see Planalp 1956, pp. 636-851). The Wisers refer to the Karimpur bhagats as "shamans", and most Madhopur ojhās also merit this appellation, since they act in varying degrees as exorcists, spirit-mediums, and faith-healers. In both cases it can be safely said that in ordinary life these "shamans"

> . . . perform the tasks assigned to the caste group to which they happen to belong. But they are set apart from ordinary men, because they are imbued with the power of appeasing certain deities. (Wiser and Wiser 1967, p. 34)

A, p. 378, line 26. Mineral or metallic substances are generally converted to ashes (bhasms) by incineration, a process typically repeated at least 21 times. Sanyal (1964) has a number of drawings and illustrations of the containers and devices used for incineration.

A, p. 379, par. 1. Mrs. Meer claimed that quicksilver or mercury

> . . . in its unchanged state, is sometimes taken to renew the constitution. One gentleman, whom I well knew, commenced with a single grain, increasing the number progressively, until his daily dose was the contents of a large table-spoon; he certainly appeared to have benefited by the practice, for his appetite and spirits were those of a man at thirty, when he had counted eighty years. (Meer 1832, Vol. I, p. 51)

However, she admitted that this use of mercury is only sometimes resorted to by individuals, and this too "without the sanction of their medical practitioners" (Ibid., Vol. I, p. 188).

A, p. 381, par. 1. The frequent application of cauterization by local Ayurvedic doctors in India in the era of British rule was often commented on--and, usually, unfavorably so--by Western writers. Rowe, for example, said:

> . . . there is scarcely a man, woman, or child, to be found who cannot show upon the face, breast, or other parts of the body, the permanent scars of the burning-iron. (Rowe 1881, p. 121)

This form of treatment was also commonly used in the treatment of sick cattle, according to Kipling, with much importance being attached to the symbolic or religious significance of the form and patterns of brand (J. L. Kipling 1891, p. 142).

As to the bleeding of patients. Mrs. Meer describes two kinds of itinerant practitioners often seen on the streets of Lucknow in 1830. One of these (usually women, not men) did dry cupping, using a buffalo's horn. The other kind were "leech-women". After the leech had drawn blood, these experts would ". . . by a particular pressure on the leech, oblige it to disgorge the blood", and would immediately place the animal in fresh water, where it would soon be ready for use again (Meer 1832, Vol. I, pp. 42-43).

B, p. 387. Prickly heat is difficult to produce experimentally, according to Ladell. It

> . . . can be relieved by rubbing extra oil into the skin and by refraining from too much soap and water; on the other hand, I myself have seen men who habitually oil themselves, rather than use soap and water, develop apparently the same lesion. (Ladell 1957, p. 190)

Controlled sun-tanning appears to be beneficial in preventing prickly heat, but sunburning interferes with perspiration (Leithead 1967, p. 744). Horne and Mole (1949, 1951) have presented evidence that a high salt intake (or a high chloride concentration in the sweat) predisposes to prickly heat, which can usually be relieved by a reduced intake. But it is characteristic of the uncertainty still surrounding this disorder that other observers have claimed the reverse to be true (Edgerton 1950). Since healed prickly heat areas may show a local diminution of sweating (Ladell 1965, p. 270), prickly heat, even if non-lethal, can surely no longer be looked upon as in any way salutory, in the 19th century manner. Ladell's judgment is that

> . . . I myself regard generalized prickly heat as a "warning sign" that the body is not adapting itself properly to the climatic conditions, or that adaptation has been temporarily upset. (Ladell 1957, p. 191)

It is interesting that medical textbooks say little about any possible exacerbations of prickly heat leading to serious complications. Perhaps this does not often occur today. But that it might have been the case in India a hundred years ago is suggested by comments that scratching prickly heat is dangerous (e.g., Meer 1832, Vol. I, p. 114).

> It comes out in a thick rash, with intense itching, and if you try to relieve that by scratching, you produce small boils or sores instead. (Brittan 1880, p. 52)

B, p. 388, par. 2. Horne has noted that there is little available information on the incidence of heat syncope and heat collapse or exhaustion precipitated by exercise, since the victims recover rapidly and rarely reach the hospital (Horne 1954, p. 365). Ladell raises the question of ethnic or racial differences in response to heat syncope, with evidence that in similar physiological test situations, Nigerian subjects are not susceptible to heat syncope, while South African "Bantus" are susceptible (Ladell 1957, p. 191).

B, p. 389, par. 2. "Punjab head", "Bengal head", etc. were names given in British India to a syndrome in which the individual, after considerable exposure to the hot climate, showed symptoms of forgetfulness and inability to concentrate attention (Rogers and Megaw 1944, p. 461).

B, p. 392, line 36. By all means, mention should have been made here of the concept of "voluntary dehydration", long since popularized by Adolph (1938, 1947). The uncompensated sweat losses of unacclimatized men may be enormous. But even acclimatized men working in the heat never voluntarily drink as much water as they lose in perspiration--usually only about 50 to 70% of this loss is compensated at the time.

> Serious dehydration, with consequent circulatory strain and hyperpyrexia, may result from this type of voluntary abstinence from water by working men, even when plenty of water is available to them. (Robinson 1963, p. 294)

At the same time, it has been often observed that many workers in the heat regularly and quite consciously incur at least slight dehydration over the course of the work day (which is compensated for by drinking large amounts of fluid afterwards):

> Many workmen believe that their fluid intake should be kept at a low level and persistently drink less than their thirst calls for, particularly during work. (Dill 1938, p. 81)

Apparently, adjustment to such a temporary loss of about 2% (but not more than 5%) of the body weight is not difficult, and Lee notes that

> Many experienced tropical dwellers . . . feel better able to cope with the situation if they delay replenishment for an hour or two after activity in the heat has commenced. (Lee 1964, pp. 564-565)

However, that this is an area of conflicting evidence is suggested by Perry's report on British army aviators in southern Arabia. Although the pilots were drinking 5 to 8 pints of liquid daily, signs of water depletion including headaches and irritability were occurring. These entirely disappeared when the intake was raised to 9 - 12 pints a day (Perry 1967, p. 218).

B, p. 393n. For a beautiful example of the blending of careful and exhaustive medical scientific research with creative expository writing of the highest caliber, no reader should fail to look at Wolf's classic monograph, Thirst, which graphically describes the episodes of death from dehydration (Wolf 1958).

B, p. 394n. Compare these figures with those given elsewhere in the text (pp. 143, 349, 494). Disparities indicate that the questions are still far from being resolved.

B, p. 395, par. 3. See Ladell's (1957) excellent discussion of the complex interrelationships among salt balance, water balance, and the intracellular fluid during exposure to heat. While granting the danger and the possibility of heat exhaustion in unacclimatized persons as a result of salt inadequacy, Ladell has also pointed to the grave danger of the opposite extreme, over-salting or infusion of double strength saline, as once was strongly advocated. He notes that, experimentally,

> . . . men given strong saline in the heat, but insufficient water, remained for a time in excellent condition, then suddenly and unpredictably collapsed. (Ladell 1957, p. 194)

B, p. 397n. In the past few years a spate of articles have appeared which claim a definite role for potassium balance in the etiology of heat injuries, including heatstroke. The process of heat acclimatization in man produces a renal conservation of sodium and chloride, and their concentration in the sweat greatly diminishes. Quite mysteriously, however, a concomitant increase in potassium excretion occurs. Both these events probably result from adrenal cortical activity, and are mediated by aldosterone. Potassium in the sweat may reach as much as 18 mEq per liter, according to Schamadan and Snively (1967, p. 786). Since low serum potassium is often seen in heatstroke victims, Knochel et al. suggested in 1961 that total body potassium deficiency may be of etiologic significance in this syndrome. Coburn and Reba (1966) also detected an association of potassium depletion with heatstroke, but noted that total body potassium balances had not yet been made on patients. Gardner (1966) examined hospital records of many of the 150 deaths attributed to heat during a prolonged heat wave in the Midwest in July 1966, and found frequent evidence of depressed serum potassium, as well as hypokalemia and Pitressin-resistant polyuria, which are features of potassium depletion.

> A large number had a common history of anorexia, refusing to eat because it was "too hot". (Schamadan and Snively 1967, p. 787)

Israeli workers have confirmed the relationship between potassium depletion and vulnerability to heat disorders (Toor et al. 1967), especially the kind observed among military recruits, football players, etc., who undergo very strenuous exercise (Knochel and Vertel 1967). The football and basketball teams at Arizona State since 1967 have experimentally (and effectively, it is reported) employed potassium-rich electrolyte solutions as an oral prophylaxis against heat stress disease (Schamadan, Godfrey, and Snively 1968).

B, p. 399, line 24. As a corrective to Manson-Bahr's assertion of the local heating effect of direct tropical sun, note the statement of Blum:

> . . . it was shown by experiments on monkeys that sunlight falling directly on the head has no direct effect on physiology . . . (Blum 1964, p. 251)

B, p. 400. Among the individuals having an increased expectancy of heatstroke, Knochel *et al*. mention children suffering from fibrocystic disease and also patients undergoing surgical procedures who have been heavily draped following the use of atropine or drugs of similar action. This last, or iatrogenic, type of heatstroke is the subject of an article by Chapman and Bean (1956).

B, p. 401. Workers at the Aero-Space Medical Laboratory at Wright-Patterson Air Force Base, in the course of studies on artificially-induced heat pyrexia, were able to initiate incipient heatstroke within an hour. In this connection, Gold's effort to describe the chronological subjective impressions and symptoms in heatstroke is the only such which I have encountered in the literature (Gold 1960b, 1964).

B, p. 402, line 15. The abnormal respiration that may occur in heatstroke simulates Kussmaul breathing (that is, even more definitely dyspneic than Cheynes-Stokes), according to Romeo (1966, p. 673).

B, p. 403. Without belaboring the point, it should be further emphasized that, despite a vast number of medical reports and experimental studies,

> The pathogenesis of heat stroke remains poorly understood . . . (Coburn and Reba 1966, p. 678)

The disorder has been an enigma through the ages, and in its acute form remains one of those with which modern medicine is least successful in coping. Ladell says quite plainly:

> Without active treatment, no subject of hyperpyrexia ever recovers . . . (Ladell 1957, p. 199)

The questions which still remain unsolved are:

1. Is the mechanism of circulatory collapse peripheral or cardiac?
2. Why do patients stop sweating?
3. What is the most effective means of reducing the pyrexia?

(Daily and Harrison 1948)

Romeo (1966) and Boname and Wilhite (1967) have recently discussed the various current therapeutic procedures, noting that choice of therapy may depend upon which of the various hypotheses as to pathogenesis is accepted by the attending physician. Based on an experimental approach, Gold postulated in 1960 that

> . . . the primary event in the circulatory collapse of heat pyrexia is high-output cardiac failure, [and] the cessation of sweating is a result of rising venous pressure . . . (Gold 1960b, p. 1175)

On these grounds, he suggested in addition to the classic treatment of rapid cooling the intravenous administration of saline solution together with rapid digitalization by a quick-acting cardiac glycoside (Ibid., p. 1182). However, the same authority in a later article appears less certain:

> . . . whether this [circulatory] collapse is of a peripheral or cardiac origin, has not been made clear. (Gold 1964, p. 413)
>
> So far, the mechanism of sweat inhibition, probably one of the most crucial questions in heatstroke, has eluded demonstration. (Ibid., p. 414)

The objection of many authorities to conventional ice treatment is based on the idea that this further increases hypermetabolism (Romeo 1966, p. 675).

B, p. 404n. This explanation was pinpointed more clearly by Ladell:

> In mines where rest pauses are not allowed and men are encouraged to work at full rate throughout the shift, severe heat illness is common. (Ladell 1964, p. 641)

B, p. 405, lines 14-16. This reference is in error. It should be the following:

Ellis, F. P. 1952. "Hot climate fatigue in the Royal Navy: a review of lay opinion", Lancet, Vol. 263, ii, pp. 527-531

C, p. 411. The wet bulb temperature is still found a useful reading in deep mines, where the air is almost fully saturated. Various investigators have determined that a 1 F.° increase in wet bulb temperature in hot mines is equivalent in its physiological effect to something between a 6 F.° and 12 F.° rise in dry bulb temperature (Wyndham, Williams, and Bredell 1965, p. 56). At the same time, however, in two conditions of equivalent wet bulb temperature, that one where the dry bulb temperature is higher will be more stressful physiologically (Ibid., p. 54).

C, p. 414. As a practical example of the unreliability of Effective Temperature as a predictor of performance where both moderately heavy work and marked differences in atmospheric humidity are involved, a study by Pepler (1958) showed that the same degree of performance decrement occurring at an ET of 84 in conditions of 20% R. H., appeared at an ET as low as 79 in conditions of 80% R. H. Effective Temperature, after all, was derived from the responses of individuals "wandering around", and thus is in effect a compromise between what might be an ideal scale for people sitting still, and those engaged in moderately heavy work (Poulton 1970, p. 137).

C, p. 417. Further along the line of evolving an index which might serve as a convenient popular or layman's term for "how hot it really feels", Lally and Watson (1960) have objected that the THI values have at least 3 defects: (1) they are not based on the cooling effect of evaporation from the human skin; (2) they rise too slowly at higher vapor pressures; and (3) they tend to confuse the average person by placing the heat discomfort threshold at 75 or 80 (since dry bulb temperatures at this point are quite comfortable). These authors therefore proposed going back to the term "humiture", but (with Thom's blessings) defined it in a quite different way as the sum of the dry bulb temperature and its concurrent "humits". They defined a "humit" as a unit of moisture, obtained by subtracting 10 from the number of millibars of vapor pressure (where this is 10 mbs. or more; if vapor pressure is 10 mbs. or less, humiture is simply equivalent to the air temperature). Thus, a temperature (dry bulb) of 90° F. with a vapor pressure of 8 mbs. gives a humiture of 90, but 90° F. with a vapor pressure of 22 produces a humiture of 102. The authors note, as a rationalization hardly calculated to impress the scientific fraternity, that

> The best reason for defining humiture as an equivalent dry-air temperature is that this is what the public has been doing by rule-of-thumb for many years.
> (Lally and Watson 1960, p. 255)

With this new definition of humiture, the "magic number" for universal discomfort is 100 rather than 80 to 85 as it is in the THI values, a fact which should have helped to give it public acceptance (but has apparently not yet done so).

C, p. 418. With reference to the influence of solar radiation, see p. 477 above. Two useful additional published studies are those of Klein (1948) and Underwood and Ward (1966).

C, p. 422, line 27. Belding and Hatch's figure of 604.8 kcal/hr of course refers to the maximum cooling power of a liter of sweat (see p. 481 above). One liter per hour is a reasonable estimate of the limit of sweat production for an average man over an 8 hr. period, even though Buskirk and Bass (1960, p. 314) stated that over 3 liters of sweat per hour may be secreted with strenuous exercise in hot weather. But much if not most of the excess over 1 liter provides no cooling power because it drips off the body.

C, p. 423, par. 2. How critically important for human survival in very hot environments is the evaporative mechanism of perspiration can be seen in those rare cases of individuals born without sweat glands. Baker says:

> Without the sweating mechanism man could not survive for long in environments over 85° F. (Baker 1958, p. 340)

However, judging from an article I recall reading in an early military medical journal (the reference has unfortunately been mislaid), even a person without sweat glands may learn to cope with fairly severe heat stress. The writer described how one soldier on march would periodically drop out of ranks and soak his shirt with water. Upon inquiry, it was found that the man had no sweat glands and had adopted this expedient in order to obtain a workable degree of evaporative cooling.

C, p. 424, par. 2. Among those who have reported racial or ethnic differences in sweat glands are Clark and Lhamon (1917) and Yoshimura (1960). But even aside from the fact that there is no significant correlation between total number of sweat glands per se and their physiological activity (Weiner 1945, p. 39), the evidence is otherwise conflicting as well. For example, Clark and Lhamon counted sweat glands on fingers and feet only, and found that Negro American soldiers had about 7% more, Filipino soldiers 17% more, Moro men 22% more, Negrito men 27% more, and some Hindu shopkeepers 32% more, sweat glands than "White" American soldiers stationed in the Philippines. Yet, the authors had no explanation for the fact that Negrito youths had 34% more sweat glands than Negrito adults (70% more than the "White" American soldiers).

A more sophisticated study, based not on counting sweat glands, but rather on measuring sweat rate responses of a number of contrasting ethnic groups in both hot-wet and hot-dry environments, is that of Strydom and Wyndham (1963). They concluded that the differences between ethnic groups were not significant, especially after acclimatization, depending ". . . mainly on extent of heat exposure and activity levels" (Strydom and Wyndham 1963, p. 806). Their most interesting finding was that residents of hot wet areas, regardless of ethnic group, or whether in Africa or in Australia, have a much higher sweat rate response than residents of hot dry areas.

There are large variations both in the density of sweat glands and in sweat output between different regions of the body, e.g., 400 glands per square centimeter on the back of the hand, but only 50 per cm^2 on the cheek. The hands, comprising only 5% of the body surface, account for 20% of the body's evaporative heat loss (Coon 1953, p. 27).

C, p. 426, par. 1. Although Lee's thermal strain index may have been little used by stress physiologists, it has been applied in at least one interesting study in India. Sivaramakrishnaiah (1966), having collated temperatures and vapor pressures for 27 stations throughout India, has constructed climograms for each month and has plotted them on Lee's strain charts in order to evaluate human comfort levels.

C, p. 437n. Probably the most up-to-date review of this subject, with large bibliography, is that of Jones (1970). This same source contains a convenient tabular summary of the principal heat stress indices in chronological sequence (Ibid., pp. 11-14).

C, p. 442, line 10. A search of the medical literature has failed to show me any really authoritative study of the heat casualties at Boulder Dam (although it seems inconceivable that such a study has not been made), and the discrepancies in the few accounts which I have uncovered certainly make me less inclined to disparage any capriciousness that may exist in contemporary Indian medical reporting. Thus, Schofield reports 150 cases of heat exhaustion and only 17 deaths from heat in the first summer (1931) and only 7 mild cases in 1932 (Schofield 1934, p. 84). A popular article (White 1935, p. 117) claimed that there were 13 heat deaths the first summer. Both these sources are at great variance with Dill (who was, however, at the scene the following year carrying out physiological studies).

The temperature data at the Dam also range widely, and tend to indicate the paramount importance of microclimatology. Although we can probably not accept laymen's statements that the temperature was "140° F. in the shade by day and above 107° at night" (Mead 1933, p. 15), or that it "did not drop below 130 during the night" (Castle 1931, p. 207), yet it is not entirely incredible that a temperature of 145° F. was at one time recorded on top of the Dam, and as much as 152° back in the diversion tunnels (White 1935, p. 117), since this last writer found a temperature of 115° F. on the floor of the canyon even in the relatively pleasant (?) month of May.

The drastic decline in casualties from 1931 to 1932 was not entirely a result of the introduction of cool dormitories and other amenities, including ample supplies of cool water and reminders to drink plenty of it (during the first summer the water was both hot and unpalatable, according to Schofield). While the average daily maximum temperature was 119° F. and the mean daily temperature was 106° F. in 1931, the comparable figures in 1932 were only 107° F. and 96° F. However, it seems that work continued through the summer of 1933, when the average daily maximum was again 112° F. and the mean temperature 104° F. During this last summer there were 13 heat casualties, 4 of them severe, with no fatalities (Schofield 1934, p. 84). Some 3000 men were working at the construction of Boulder Dam.

LIST OF REFERENCES

Adolph, E. F. 1938. "Heat exchanges of man in the desert", American Journal of Physiology, Vol. 123, pp. 486-499

Adolph, E. F. and Associates. 1947. Physiology of Man in the Desert. New York: Interscience Publishers

Alexander, C. Alex. 1969. Traditional Healers in a Region of Mysore. Paper presented to the annual meeting of the American Anthropological Association, New Orleans, La., Nov. 20, 1969 (Manuscript) (to be published in Social Science and Medicine, 1971)

Baden Powell, B. H. 1872. Hand-book of the Manufactures and Arts of the Punjab. Lahore: Punjab Printing Co.

Baker, Paul. 1958. "The biological adaptation of man to hot deserts", The American Naturalist, Vol. 42, pp. 337-357

Banerji, Niant Dhay. 1929. "Indian dietaries in the United Provinces", Indian Medical Gazette, Vol. 64, pp. 183-186

Barnicot, N. A. 1959. "Climatic factors in the evolution of human populations", pp. 115-129 in Genetics and Twentieth Century Darwinism (Cold Spring Harbor Symposia on Quantitative Biology, Vol. XXIV). Cold Spring Harbor, L. I., New York: The Biological Laboratory

Bazett, H. C. 1927. "Physiological responses to heat", Physiological Reviews, Vol. 7, pp. 531-599

Bell, Evelyn. 1939. Memory Be Good. London: Michael Joseph Ltd.

Bennett, John W. 1967. "On the cultural ecology of Indian cattle", Current Anthropology, Vol. 8, pp. 251-252

Beny, Roloff. 1969. India. New York: McGraw-Hill Book Co.

Bhaṇḍārī, Shrīcandrarāj "Vishārad". 1951. Vanaushadhi-Candrōday (An Encyclopaedia of Indian Botanys and Herbs). Varanasi: Chowkhamba Sanskrit Series Office (in Hindi)

Blanchard, Sidney Laman. 1867. Yesterday and To-day in India. London: Wm. H. Allen

Blum, Harold F. 1961. "Does the melanin pigment of human skin have adaptive value?", Quarterly Review of Biology, Vol. 36, pp. 50-63

_____. 1964. "Effects of sunlight on the human body". pp. 229-256 in Medical Climatology (Sidney Licht, ed.). Baltimore: Waverley Press

Boname, John R. and Wilhite, Wilson C. Jr. 1967. "The acute treatment of heat stroke", <u>Southern Medical Journal</u>, Vol. 60, pp. 885-887

Brittan, Harriet G. 1880. <u>A Woman's Talks About India.</u> Philadelphia: American Sunday-School Union

Burch, George E. and DePasquale, Nicholas P. 1962. <u>Hot Climates, Man and his Heart</u>. Springfield, Illinois: Charles C. Thomas

Burridge, W. 1926. <u>Indigenous Systems and Medical Science</u>. Allahabad.

Buskirk, Elsworth R. and Bass, David E. 1960. "Climate and exercise", pp. 311-338 in <u>Science and Medicine of Exercise and Sports</u> (Warren R. Johnson, ed.). New York: Harper and Brothers

Caplan, A. 1944. "Critical analysis of collapse in underground workers on the Kolar Gold Field", <u>Transactions of the Institution of Mining and Metallurgy</u>, Vol. 53, pp. 95-179

Castle, Victor. 1931. "Well, I quit my job at the dam", <u>The Nation</u>, Vol. 133, pp. 207-208

Chakladar, H. C. 1963. "The geography of Kālīdāsa", <u>Indian Studies</u>, Vol. 4, pp. 411-457

Chandler, T. J. 1970. <u>Selected Bibliography on Urban Climate</u>. Geneva: World Meteorological Organization (No. 276, TP. 155)

Chapman, John and Bean, W. B. 1956. "Iatrogenic heat stroke", <u>Journal of the American Medical Association</u>, Vol. 161, pp. 1375-1377

Clark, Elbert and Lhamon, Rushkin H. 1917. "Observations on the sweat glands of tropical and northern races", <u>Anatomical Record</u>, Vol. 12, pp. 139-147

Clark, R. M., Langar, P. R., and Taylor, W. S. 1941. "Social effects of change in religious outlook among Indian villagers", <u>The Sociological Review</u>, Vol. 33, pp. 37-55

Cockburn, W. 1891-1895. "Physical differences between Europeans and Asiatics", <u>North Indian Notes and Queries</u>, Vol. II, pp. 175-176, 193-194, 203; Vol. III, pp. 114-116; Vol. IV, pp. 8-9

Collumbine, H. 1950. "Heat production and energy requirements of tropical people", <u>Journal of Applied Physiology</u>, Vol. 2, pp. 640-653

Cook, Nilla Cram. 1939. <u>My Road to India</u>. New York: Lee Furman, Inc.

Coon, Carleton S. 1953. "Climate and race", pp. 13-34 in <u>Climatic Change</u> (Harlow Shapley, ed.). Cambridge: Harvard University Press

Coon, Carleton S. and Hunt, E. E. 1965. The Living Races of Man. New York: Alfred A. Knopf

Daily, W. M. and Harrison, T. R. 1948. "A study of the mechanism and treatment of experimental heat hyperpyrexia", American Journal of the Medical Sciences, Vol. 215, pp. 42-55

Danks, D. M., Webb, D. W., and Allen, Jean. 1962. "Heat illness in infants and young children", British Medical Journal, August 4, 1962, pp. 287-293

Davy, H. N. 1946. "A psychologist's reactions in India", Asia and the Americas, Vol. 46, pp. 151-154, 218-222

Dérobert, L. 1939. Les troubles de la thermorégulation. Paris: Masson

Dill, David Bruce. 1938. Life, Heat, and Altitude. Cambridge: Harvard University Press

District Gazetteers of the United Provinces of Agra and Oudh. Vol. XXXIII. 190-. Azamgarh: a Gazetteer. Allahabad

Dube, S. C. 1955. Indian Village. Ithaca: Cornell University Press

Dubois, Abbe J. A. 1906. Hindu Manners, Customs and Ceremonies. Oxford: Clarendon Press (3d ed.)

Duncan, Andrew. 1907. "The actinic theory of sunstroke", Journal of Tropical Medicine and Hygiene, Vol. 10, p. 83

Durnin, J. V. G. A. and Passmore, R. 1967. Energy, Work and Leisure. London: Heinemann Educational Books, Ltd.

Edwardes, Michael. 1969. Bound to Exile. New York: Praeger Publishers

Elwin, Edward F. 1913. India and the Indians. London: John Murray

Fales, Louis H. 1907. "Tropical neurasthenia and its relation to tropical acclimation", American Journal of the Medical Sciences, Vol. 133, pp. 582-593

Fayrer, Sir Joseph. 1900. Recollections of my Life. Edinburgh: William Blackwood and Sons

Fisher, Welthy Honsinger. 1926. The Top of the World. New York: The Abingdon Press

Folk, G. Edgar Jr. 1966. Introduction to Environmental Physiology. Philadelphia: Lea and Febiger

Fonseca, Rory. 1971. "The walled city of Old Delhi", Ekistics, Vol. 31, pp. 72-80

Foulds, Captain M. F. 1906. "A little-known treatment for sunstroke", Journal of the Royal Army Medical Corps, Vol. 7, pp. 604-605

Fourt, Lyman and Hollies, Norman R. S. 1970. Clothing: Comfort and Function. New York: Marcel Dekker

Freer, Paul C. 1912. "The result of the past two years' work in the study of tropical sunlight", The Philippine Journal of Science, Vol. 7 (B), pp. 1-28

Gaikwad, V. R. 1967. The Anglo-Indians. Bombay: Asia Publishing House

Gandhi, Rajnikant S. 1970. "Conflict and cohesion in an Indian student community", Human Organization, Vol. 29, pp. 95-102

Gardner, D. 1966. "Potassium metabolism and potassium therapy", Journal of the American Osteopathic Association, Vol. 66, pp. 257-270

Gardner, Mona. 1939. The Menacing Sun. New York: Harcourt, Brace and Co.

Garn, Stanley M. 1969. Human Races. Springfield, Illinois: C. C. Thomas (2d ed.)

Ghosh, Bhirendra Nath and Das, Jahar Lal. 1915. A Treatise on Hygiene and Public Health. Calcutta: Hilton and Co. (2d ed.)

Gold, Joseph. 1960a. "Calorie neutralization during thermal stress", Aerospace Medicine, Vol. 31, pp. 933-940

_____. 1960b. "Development of heat hyperpyrexia", Journal of the American Medical Association, Vol. 173, pp. 1175-1182

_____. 1964. "Pathologic effects of heat exposure", pp. 400-427 in Medical Climatology (Sidney Licht, ed.). Baltimore: Waverley Press

Gordon, Benjamin Lee. 1959. Medieval and Renaissance Medicine. New York: Philosophical Library

Grande, Francisco. 1964. "Man under caloric deficiency", pp. 911-937 in Handbook of Physiology. Section 4: Adaptation to the Environment (D. B. Dill, ed.). Washington, D. C.: American Physiological Society

Gupta, Sankar Sen (ed.) 1963. Rain in Indian Life and Lore. Calcutta: Indian Publications

Harris, Marvin. 1966. "The cultural ecology of India's sacred cattle", Current Anthropology, Vol. 7, pp. 51-60

Hasan, K. A. 1971. "The Hindu dietary practices and culinary rituals in a North Indian village: an ethnomedical and structural analysis", Ethnomedizin, Vol. 1, No. 1

Henrotte, J. G. 1966. "A biological study of Indian populations at different levels of economic growth", pp. 395-406 in Human Adaptability to Environments and Physical Fitness (M. S. Malhotra, ed.). Madras: Defence Institute of Physiology and Allied Sciences

Hertig, B. A. and Sargent, F. II. 1963. "Acclimatization of women during work in hot environments", Federation Proceedings, Vol. 22, pp. 810-813

Hervey, Captain Albert. 1850. Ten Years in India. London: William Shoberl (3 vols.)

Heston, Alan. 1971. "An approach to the sacred cow of India", Current Anthropology, Vol. 12, pp. 191-210

Hill, S. A. 1888. "Life statistics of an Indian province", Nature, Vol. 38, pp. 245-250

Honigberger, John Martin. 1852. Thirty-five Years in the East. London: H. Bailliere

Horne, G. O. 1954. "The effects of environmental heat", Edinburgh Medical Journal, Vol. n.s. 61, pp. 349-366

Horne, G. O. and Mole, R. H. 1949. "The effect of water and salt intake on prickly heat", The Lancet, Vol. 257, ii, pp. 279-281

_. 1951. "Comparative physiological observations on prickly heat, mamillaria and anhidrotic heat exhaustion", Transactions of the Royal Society of Tropical Medicine and Hygiene, Vol. 45, pp. 75-90

Howe, Paul E. and Berryman, George H. 1945. "Average food consumption in the training camps of the United States Army (1941-1943)", American Journal of Physiology, Vol. 144, pp. 588-594

Human Relations Area Files. 1964. Food Habits Survey. New Haven: HRAF (unpublished report) (2 vols.)

Hunt, Virginia Lloyd. 1942. How to Live in the Tropics. New York: Harcourt, Brace and Co.

Hutchinson, F. H. G. 1926. "Heat-stroke in All Independent Brigade Area in relation to meteorological conditions", Indian Journal of Medical Research, Vol. 14, pp. 53-100

India News (Embassy of India, Washington, D. C.)

Indian Council of Medical Research. 1956. Report of Work Done in Nutrition in States 1954-1955. New Delhi: ICMR

Indian Economic Diary. 1970. Vol. 1, No. 46 (Nov. 12-18, 1970)

Indian Institute of Public Opinion. 1968. "The measurement of Indian poverty 1950-1980", Quarterly Economic Report, Vol. 15, No. 2, pp. 15-36

_____. 1969. "Urban and rural attitudes towards family planning", Monthly Public Opinion Surveys, No. 163 (February), pp. 3-34

The Indian National Bibliography. 1958+ . New Delhi: Ministry of Education. Central Reference Library.

Jones, R. Douglas. 1970. Effects of Thermal Stress on Human Performance: a Review and Critique of Existing Methodology. U. S. Army. Human Engineering Laboratories, Aberdeen Research and Development Center, Aberdeen Proving Ground, Maryland. (Technical Memorandum 11-70)

Kaunitz, Hans. 1956. "Causes and consequences of salt consumption", Nature, Vol. 178, pp. 1141-1144

Keusen, Hans. 1958. South Asia. New York: Frederick A. Praeger

Khare, R. S. 1970. The Changing Brahmans. Chicago: The University of Chicago Press

Kipling, John Lockwood. 1891. Beast and Man in India. London: Macmillan

Klein, William H. 1948. "Calculation of solar radiation and the solar heat load on man", Journal of Meteorology, Vol. 5, pp. 119-129

Knochel, J. P., Beisel, William R., Herndon, E. G. Jr., Gerard, Earl S., and Barry, Kevin G. 1961. "The renal, cardiovascular, hematologic and serum electrolyte abnormalities of heat stroke", American Journal of Medicine, Vol. 30, pp. 299-309

Knochel, J. P. and Vertel, R. M. 1967. "Hypothesis: salt-loading as possible factor in the production of potassium depletion, rhabdomyolysis and heat injury", The Lancet, March 25, 1967, pp. 659-661

Ladell, W. S. S. 1957. "Disorders due to heat", Transactions of the Royal Society of Tropical Medicine and Hygiene, Vol. 51, pp. 189-216

_____. 1964. "Terrestrial animals in humid heat: man", pp. 625-660 in Handbook of Physiology. Section 4: Adaptation to the Environment (D. B. Dill, ed.). Washington, D. C.: American Physiological Society

_____. 1965. "Water and salt (sodium chloride) intakes", pp. 235-290 in The Physiology of Human Survival (O. G. Edholm and A. L. Bacharach, eds.). London: Academic Press

Lally, Vincent E. and Watson, Bruce F. 1960. "Humiture revisited", Weatherwise, Vol. 13, pp. 254-256

Lee, Douglas H. K. 1935. "The human organism and hot environments", Transactions of the Royal Society of Tropical Medicine and Hygiene, Vol. 29, pp. 7-30

_____, 1950. "Physiology as a guide to combating tropical stress", The New England Journal of Medicine, Vol. 243, pp. 723-730

_____. 1964. "Terrestrial animals in dry heat: man in the desert", pp. 551-582 in Handbook of Physiology. Section 4: Adaptation to the Environment (D. B. Dill, ed.). Washington, D. C.: American Physiological Society

Leithead, Charles S. 1967. "Prevention of the disorders due to heat", Transactions of the Royal Society of Tropical Medicine and Hygiene, Vol. 61, pp. 739-745

Leix, A. 1940. "Indian costumes", Ciba Review, No. 36, pp. 1282-1311

Leslie, Charles. 1971. Personal communication

Löfstedt, Börje. 1966. Human Heat Tolerance. Lund: Department of Hygiene, University of Lund

Machle, Willard and Hatch, T. F. 1947. "Heat: man's exchanges and physiological responses", Physiological Reviews, Vol. 27, pp. 200-227

Maclennan, A. 1970. "A medical officer in the Mutiny", Journal of the Royal Army Medical Corps, Vol. 116, pp. 206-215

Macleod, R. D. 1938. Impressions of an Indian Civil Servant. London: H. F. and G. Witherby Ltd.

Mann, Ida. 1966. Culture, Race, Climate and Eye Disease. Springfield, Illinois: Charles C. Thomas

Mead, Elwood. 1933. "The construction of Boulder Dam", The Literary Digest, Vol. 116, Nov. 4, p. 15

Meer, Mrs. Hassan Ali. 1832. Observations on the Mussulmauns of India. London: Parbury, Allen, and Co. (2 vols.)

Menpes, Mortimer. 1905. India. London: Adam and Charles Black

Military Medicine. 1966. "Heat ruled the day", p. 677

Minard, David. 1967a. "Evaluation of heat stress under working conditions", pp. 57-73 in Industry and Tropical Health, VI. Proceedings of the 6th Conference of the Industrial Council for Tropical Health. Boston: Harvard School of Public Health

_____. 1967b. "Studies and recent advances in military problems of heat acclimatization", Military Medicine, Vol. 132, pp. 306-315

Morimoto, T., Slabochova, Z., Naman, R. K., and Sargent, F. II. 1967. "Sex differences in physiological reactions to thermal stress", Journal of Applied Physiology. Vol. 22, pp. 526-532

Munson, Arley. 1913. Jungle Days. New York and London: D. Appleton

Nag, Moni. 1962. Factors Affecting Human Fertility in Nonindustrial Societies: a Cross-cultural Study. New Haven: Department of Anthropology, Yale University (Yale University Publications in Anthropology, No. 66)

National Academy of Sciences. National Research Council. 1968. Recommended Dietary Allowances. A Report of the Food and Nutrition Board. Washington, D. C.

Neill, Roderick. 1970. "Sadhus and hippies", Quest, No. 65 (April-June), pp. 20-27

Nelson, N., Eichna, L. W., Horvath, S. M., Shelley, W. B., and Hatch, T. F. 1947. "Thermal exchanges of man at high temperatures", American Journal of Physiology, Vol. 151, pp. 626-652

New York Times. 1971

Newby, Eric. 1966. Slowly Down the Ganges. New York: Charles Scribner's Sons

Newcombe, A. C. 1905. Village, Town, and Jungle Life in India. Edinburgh and London: William Blackwood and Sons

North Indian Notes and Queries (William Crooke, ed.). 1891-1895

Nurge, Ethel. 1970. "Birth rate and work load", American Anthropologist, Vol. 72, pp. 1434-1439

Palmer, Arnold. 1952. Movable Feasts. London: Oxford University Press

Pandey, Suresh. 1961. "The hot weather season in Bihar", Geographical Review of India, Vol. 23, pp. 41-46

Pandian, T. B. 1898. Indian Village Folk. London: Elliot Stock

Passmore, R. and Durnin, J. V. G. A. 1955. "Human energy expenditure", Physiological Reviews, Vol. 35, pp. 801-840

Pennell, T. L. 1912. Things Seen in Northern India. New York: E. P. Dutton and Co.

Pepler, R. D. 1958. "Warmth and performance: an investigation in the tropics", Ergonomics, Vol. 2, pp. 63-88

Perry, I. C. 1967. "A medical survey of climatic effects on army aviators operating in South Arabia", Journal of the Royal Army Medical Corps, Vol. 113, pp. 213-219

Planalp, Jack M. 1956. Religious Life and Values in a North Indian Village. Ph. D. Dissertation, Cornell University (University Microfilms No. 56-979)

_____. 1966. Cold Injuries in the Tropics: the North Indian Cold Wave of 1961. Natick, Mass.: U. S. Army Research Institute of Environmental Medicine (unpublished manuscript)

Poulton, E. C. 1970. Environment and Human Efficiency. Springfield, Illinois: Charles C. Thomas

Price, Weston A. 1939. Nutrition and Physical Degeneration. New York: Paul B. Hoeber

Pym, Michael. 1930. The Power of India. New York: G. P. Putnam's Sons

Rafatjah, H. 1971. "The problem of resurgent bed-bug infestation in malaria eradication programmes", The Journal of Tropical Medicine and Hygiene, Vol. 74, pp. 53-56

Rao, C. N. 1966. "A survey of diets in residential hostels in India", Indian Journal of Medical Research, Vol. 54, pp. 475-479

Renbourn, E. T. 1957. "The history of the flannel binder and cholera belt", Medical History, Vol. 1, pp. 211-225

_____. 1962. "Life and death of the solar topi", Journal of Tropical Medicine and Hygiene, Vol. 65, pp. 203-218

_____. 1963. "Seasoning fluxes and fevers of acclimatization. An introduction to the history of tropical adaptation", Journal of Tropical Medicine and Hygiene, Vol. 66, pp. 193-203

_____. 1965. Human Factors Problems in Tropical Climates, Particularly of Jungle Warfare. Paper presented to the Eighth Commonwealth Defence Conference on Clothing and General Stores (Australia)

Renou, Marie-Simone. 1969. The India I Love. New York: Tudor Publishing Co.

Robinson, Sid. 1963. "Circulatory adjustments of men in hot environments", pp. 287-297 in Temperature: Its Measurement and Control in Science and Industry. Vol. III, Part 3 (James D. Hardy, ed.). New York: Reinhold Publishing Corp.

Rogers, Leonard. 1908. "The relationship of the temperature and moisture of the atmosphere to the incidence of heat-stroke", Journal of the Royal Army Medical Corps, Vol. 10, pp. 25-33

Rogers, Sir Leonard and Megaw, Sir John W. D. 1944. Tropical Medicine. Baltimore: The Williams and Wilkins Co. (5th ed.)

Romeo, Joseph A. 1966. "Heatstroke", Military Medicine, Vol. 131, pp. 669-677

Rowe, A. D. 1881. Every-day Life in India. New York: American Tract Society

Russell, Sir E. John. 1954. World Population and World Food Supplies. London: George Allen and Unwin Ltd.

Rutledge, Denys. 1962. In Search of a Yogi. New York: Farrar, Straus

Sahgal, Nayantara. 1962. From Fear Set Free. London: Victor Gollancz

Salem, S. N. 1966. "Neurological complications of heat-stroke in Kuwait", Annals of Tropical Medicine and Parasitology, Vol. 60, pp. 393-400

Sambon, Louis W. 1907. "Tropical clothing", Journal of Tropical Medicine and Hygiene, Vol. 10, pp. 67-69

Sanyal, P. K. 1964. A Story of Medicine and Pharmacy in India. Calcutta: Shri Amitava Sanyal

Sargent, Frederick II. 1964. "The environment and human health", pp. 19-32 in Environmental Physiology and Psychology in Arid Conditions. Proceedings of the Lucknow Symposium. Paris: UNESCO

Schamadan, J. L., Godfrey, W. R., and Snively, W. D. Jr. 1968. "Evaluation of potassium-rich electrolyte solutions as oral prophylaxis for heat stress disease", Industrial Medicine and Surgery, Vol. 37, pp. 677-684

Schamadan, James L. and Snively, W. D. Jr. 1967. "The role of potassium in heat stress disease", Industrial Medicine and Surgery, Vol. 36, pp. 785-788

Schmid, Peter. 1961. India: Mirage and Reality. New York: Pitman Publishing Corp.

Schofield, Richard O. 1934. "Heat prostration--its treatment at Boulder Dam", California and Western Medicine, Vol. 41, pp. 83-86

Schreider, Eugene. 1957. "Ecological rules and body-heat regulation in man", Nature, Vol. 179, pp. 915-916

Sen, R. N. and Associates. 1964a. Assessment of Work Load and Thermal Stress in Relation to Physiological Responses of Workers in a Cotton Mill in Bombay. New Delhi: Ministry of Labour and Employment. Industrial Physiology Division. (Report No. 3)

_____. 1964b. Assessment of Work Load and Thermal Stress in Relation to Physiological Responses of Workers in a Soap Factory in Bombay. New Delhi: Ministry of Labour and Employment. Industrial Physiology Division (Report No. 4)

Seymour, John. 1953. Round About India. London: Eyre and Spottiswoode

Shahani, Ranjee Gurdarsing. 1939. Indian Pilgrimage. London: Michael Joseph Ltd.

Shils, Edward. 1970. "The academic profession in India", pp. 172-200 in Elites in South Asia (Edmund Leach and S. N. Mukherjee, eds.). Cambridge: University Press

Shirreff, A. G. 1936. "Hindi folk-songs", Journal of the Royal Asiatic Society, pp. 209-223

Singh, Bhupal. 1934. A Survey of Anglo-Indian Fiction. London: Oxford University Press

Singh, Khushwant. 1956. Train to Pakistan. London: Chatto and Windus

Singh, Thakur Rajendra. 1926. Glimpses of Village Life in Northern India. Calcutta: Thacker, Spink

Sivaramakrishnaiah, K. 1966. "A study of human comfort of some places in India", Indian Journal of Meteorology and Geophysics, Vol. 17, pp. 89-94

Spate, O. H. K. and Learmonth, A. T. A. 1967. India and Pakistan: a General and Regional Geography. London: Methuen and Co. Ltd.

Srinivas, M. N. 1952. Religion and Society among the Coorgs of South India. Oxford: Clarendon Press

Srivastava, K. K. and Kaur, S. 1965. "Animal metabolism and nutritional requirement under physiological stress-variation in ambient temperature", Defence Sciences Journal, Vol. 15, pp. 49-66

Stamp, L. Dudley. 1964. Some Aspects of Medical Geography. London: Oxford University Press

Stephens, Ian. 1966. Monsoon Morning. London: Ernest Benn

Stolwijk, J. A. J. 1969. "Thermoregulatory responses of men and women at rest to sudden changes in environmental temperature", pp. 28-29 in Biometeorology, Vol. 4, Part II (S. W. Tromp and W. H. Weihe, eds.). Amsterdam: Swets and Zeitlinger N. V.

Strydom, N. B. and Wyndham, C. H. 1963. "Natural state of heat acclimatization of different ethnic groups", Federation Proceedings, Vol. 22, pp. 801-808

Sundstroem, E. S. 1927. "The physiological effects of tropical climate", Physiological Reviews, Vol. 7, pp. 320-362

Taj-eldin, Salman and Falaki, Najla. 1968. "Heat illness in infants and small children in desert climates", The Journal of Tropical Medicine and Hygiene, Vol. 71, pp. 100-104

Tandon, Prakash. 1968. Punjabi Century. Berkeley: University of California Press

Taylor, Carl E. 1971. Personal communication

Tennant, William. 1804. Indian Recreations. London: C. Stewart (2 vols.)

Thaliath, J. 1962. "Notes on the Kurmis of north-eastern Madhya Pradesh", Anthropos, Vol. 57, pp. 112-166

Thoburn, W. C. 1946. "The comfort problem in northern India", Heating, Piping and Air Conditioning, Vol. 18, pp. 120-125

Tichy, Herbert. 1938. Tibetan Adventure. London: Faber and Faber Ltd.

Time. 1971. "Curing an ill wind", June 14, 1971, pp. 73-74

Toor, M., Agmon, J., Zahavi, I., Wurzel, M., and Rosenfeld, J. B. 1967. "Potassium depletion in permanent inhabitants of hot areas", Israel Journal of Medical Sciences, Vol. 3, pp. 149-151

"A. U." 1873. Overland, Inland, and Upland. London: Seeley, Jackson, and Halliday

Underwood, C. R. and Ward, E. J. 1966. "The solar radiation area of man", Ergonomics, Vol. 9, pp. 155-168

Upādhyāya, Krishṇadeva. 1949. Bhojpūrī Grām-gīt. Prayāg: Hindī Sāhitya Sammēlan (in Hindi)

______.1955. Bhojpūrī Lōk-gīt. Prayāg: Hindī Sāhitya Sammēlan (in Hindi)

Watts, Alan. 1970. "The future of religion", pp. 296-303 in Toward Century 21 (C. S. Wallia, ed.). New York: Basic Books, Inc.

Weiner, J. 1945. "The regional distribution of sweating", Journal of Physiology, Vol. 104, pp. 32-40

Weinman, K. P., Slabochova, Z., Bernauer, E. M., Morimoto, T., and Sargent, F. II. 1967. "Reactions of men and women to repeated exposure to humid heat", Journal of Applied Physiology, Vol. 22, pp. 533-538

Wernher, Hilda. 1945. My Indian Family. New York: The John Day Company

Whelan, M. E., MacHattie, L. E., Goodings, A. C., and Turl, L. H. 1955. "The diffusion of water vapor through laminae, with particular reference to textile fabrics", Textile Research Journal, Vol. 25, pp. 197-223

White, Colonel Bob. 1957. "West African chop", Gourmet, Vol. 17, pp. 16-17, 78-81

White, Theo. 1935. "Building the big dam", Harper's, Vol. 171, pp. 113-121

Willcox, W. H. 1920. "Heat hyperpyrexia", Transactions of the Medical Society of London, Vol. 43, pp. 207-237

Williams, Gertrude Marvin. 1928. Understanding India. New York: New York: Coward-McCann, Inc.

Wilson, Ove. 1956. "Adaptation of the basal metabolic rate of man to climate: a review", Metabolism, Vol. 5, pp. 531-542

Wiser, William H. and Wiser, Charlotte Viall. 1967. Behind Mud Walls 1930-1960. Berkeley: University of California Press

Wolf, A. V. 1958. Thirst. Springfield, Illinois: Charles C. Thomas

Woodcock, Alan H. 1964. "Clothing and climate", pp. 557-580 in Medical Climatology (Sidney Licht, ed.). Baltimore: Waverley Press

Woolf, Barnet. 1954. "Statistical aspects of dietary surveys", Proceedings of the Nutrition Society, Vol. 13, pp. 82-84

Workman, William Hunter and Workman, Fanny Bullock. 1904. Through Town and Jungle. New York: Charles Scribner's Sons

Wyndham, C. H., Williams, C. G., and Bredell, G. A. G. 1965. "The physiological effects of different gaps between wet and dry-bulb temperatures at high wet-bulb temperatures", Journal of the South African Institute of Mining and Metallurgy, Vol. 66, pp. 52-57

Yeats-Brown, F. 1945. Martial India. London: Eyre and Spottiswoode

GENERAL BIBLIOGRAPHY

The following is a list of selected and recommended general references on the main subjects covered in this report. It includes especially the edited volumes--those having collections of papers from contributors--as well as a number of sources not mentioned in the text.

Adolph, E. F. and Associates. 1947. Physiology of Man in the Desert. New York: Interscience Publishers

Baker, Paul and Weiner, J. S. (eds.) 1966. The Biology of Human Adaptability. Oxford: Clarendon Press

Bose, Nirmal Kumar (ed.) 1961. Peasant Life in India: a Study in Indian Unity and Diversity. Calcutta: Anthropological Survey of India

Critchfield, Howard J. 1966. General Climatology. Englewood Cliffs, N. J.: Prentice-Hall, Inc. (2d ed.)

Dill, D. B. (ed.) 1964. Handbook of Physiology. Section 4: Adaptation to the Environment. Washington, D. C.: American Physiological Society

Dwarkanath, C. S. 1959. Introduction to Kayachikitsa. Bombay: Popular Book Depot

Federation Proceedings (Vol. 22). 1963. Proceedings of the International Symposium on Temperature Acclimation, Leiden, Sept. 5-7, 1962

Folk, G. Edgar Jr. 1966. Introduction to Environmental Physiology. Philadelphia: Lea and Febiger

Grimes, Annie E. 1964. An Annotated Bibliography of Climatic Maps of India. Washington, D. C.: U. S. Department of Commerce. U. S. Weather Bureau

Hardy, James D. (ed.) 1963. Temperature: Its Measurement and Control in Science and Industry. Vol. III, Part 3 (Biology and Medicine).

_____. 1970. Proceedings, Symposium on Physiological and Behavioral Temperature Regulation, 19-23 August 1968. 24th International Congress of Physiological Sciences. Springfield, Ill.: C. C. Thomas

India. Ministry of Education. Central Reference Library. 1958 +. The Indian National Bibliography. New Delhi

India. Central Gazetters Unit. 1965. The Gazetteer of India: Indian Union. New Delhi: Ministry of Information and Broadcasting

Indian Council of Medical Research. Nutrition Research Laboratories. 1964. Diet Atlas of India. Hyderabad

Institute of History of Medicine and Medical Research (Delhi). 1962. Theories and Philosophies of Medicine. Delhi

Leithead, C. S. and Lind, A. R. (eds.) 1964. Heat Stress and Heat Disorders. Philadelphia: F. A. Davis

Licht, Sidney (eds.) 1964. Medical Climatology. Baltimore: Waverley Press

Lisbon. Sixth International Congress on Tropical Medicine and Malariology, Sept. 5-13. 1958. Proceedings, Vol. VI

McDivitt, M. and Mudambi, S. R. 1969. Human Nutrition: Principles and Applications in India. New Delhi: Prentice-Hall

Malhotra, Mangal Sain (ed.) 1966. Human Adaptability to Environments and Physical Fitness. Madras: Defence Institute of Physiology and Allied Sciences

Mandelbaum, David. 1970. Society in India. Berkeley: University of California Press (2 vols.)

Mitchell, H. H. and Edman, Marjorie. 1951. Nutrition and Climatic Stress. Springfield, Illinois: Charles C. Thomas

National Research Council. National Academy of Sciences. Division of Medical Sciences. 1962. Tropical Health. Washington, D. C.

Newburgh, L. H. (ed.) 1949. Physiology of Heat Regulation and the Science of Clothing. Philadelphia: W. B. Saunders Co.

Sargent, Frederick II and Tromp, S. W. (eds.) 1964. A Survey of Human Biometeorology. Geneva: World Meteorological Organization (Technical Note 65)

Spate, O. H. K. and Learmonth, A. T. A. 1967. India and Pakistan: a General and Regional Geography. London: Methuen and Co. Ltd.

Sundstroem, E. S. 1927. "The physiological effects of tropical climate", Physiological Reviews, Vol. 7, pp. 320-362

Tromp, S. W. and Weihe, W. H. (eds.) 1962 +. Biometeorology. (Proceedings of the International Bioclimatological Congresses)

Udupa, K. N. and Associates (eds.) 1970. Advances in Research in Indian Medicine. Varanasi: Banaras Hindu University

United Nations Educational, Scientific and Cultural Organization. 1957. Human and Animal Ecology. Paris

_____. 1958. Climatology. Reviews of Research. Paris

_____. 1963. Environmental Physiology and Psychology in Arid Conditions. Reviews of Research. Paris

_____. 1964. Environmental Physiology and Psychology in Arid Conditions. Proceedings of the Lucknow Symposium. Paris

United States. Department of the Army. 1964. U. S. Army Area Handbook for India. Washington, D. C.

Uttar Pradesh. Directorate-General of Medical and Health Services. 1961. Report on the State of Health of Uttar Pradesh. Lucknow

Winslow, C.-E. A. and Herrington, L. P. 1949. Temperature and Human Life. Princeton, N. J.: Princeton University Press

Wulsin, Frederick R. 1949. "Adaptations to climate among non-European peoples", pp. 3-69 in Physiology of Heat Regulation and the Science of Clothing. Philadelphia: W. B. Saunders Co.

Yoshimura, H., Ogata, K., and Itoh, S. (eds.) 1960. Essential Problems in Climatic Physiology. Kyoto: Nankodo

Other references cited (in Preface, etc.):

Dey, S. K. 1969. Power to the People? Bombay: Orient Longmans

Dickinson, J. C. 1874. Tropical Debility: a Treatise on the Causes and Treatment of Debility Produced by Prolonged Residence in the Tropics. London: Balliere, Tindall, and Cox

Marriott, McKim (ed.) 1955. Village India. The American Anthropological Association, Memoir No. 83

Nossiter, Bernard. 1970. Soft State. New York: Harper Brothers

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) U. S. Army Research Institute of Environmental Medicine Natick, MA 01760	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED
	2b. GROUP

3. REPORT TITLE

HEAT STRESS AND CULTURE IN NORTH INDIA

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

FINAL

5. AUTHOR(S) (First name, middle initial, last name)

Jack M. Planalp

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
30 July 1971	557	900

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO. 3A025601A827	
c.	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) N/A
d.	

10. DISTRIBUTION STATEMENT

Distribution of this document is unlimited

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
N/A	U. S. Army Medical R&D Command Department of the Army Washington, D. C. 20314

13. ABSTRACT (U) This study delineates interrelationships between the thermal environment, especially the prolonged seasonal heat stress, and human life and culture in North India The subject is first treated historically, with a survey of the ideals and behavior of man's adaptation to the climate in ancient and medieval India, and in colonial Anglo-Indian society. Present-day adaptations to the climate, as reflected in housing, clothing, technology, daily regimen, and diet are described and examined in greater detail. These include some discussion of the seasonality of births, the general state of scientific knowledge about nutrition in the heat, and an analysis of the composition and adequacy of North Indian diets.

The second part of the report centers on heat injuries, with a survey of their worldwide epidemiology, and statistics and maps showing their incidence since 1960 in the state of Uttar Pradesh. These U. P. epidemiological data are analyzed, and a case study of the June 1966 heat wave in Bihar indicates the practical difficulties in accurately assessing climatic effects. The folk beliefs, concepts and therapy which are generally applied in rural North India to the occurrence of heat injuries are described and examined. This requires an appraisal of the indigenous system of Hindu medicine, Ayurveda, and the role of medical heterodoxies vis-a-vis Western medicine in modern India. Appendices further describe the recognized heat disorders and the scientific indices for assessing comfort and heat stress.

UNCLASSIFIED

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
India; heat stress; heat disabilities; behavior; culture; medicine (Indian)						

UNCLASSIFIED

Security Classification